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DISCOVERY BY BARON NORDENSKJÖLD THAT FRESH WATER WILL BE FOUND BY BORING THROUGH HARD CRYSTALLINE ROCK FOR 30 TO 35 METRES.

By Sir CLEMENTS R. MARKHAM, K.C.B., F.R.S.

Baron Nordenskjöld's system of boring for fresh water through the granite rocks of Sweden has now been in operation for two years, with the result that as many as forty-four wells have been made. This is not alone a question of greater or less success in finding water, but of the discovery of a new and important geological principle leading to weighty economic and hygienic results.

The difficulty that was found in obtaining good drinking-water at many of the pilot and light stations situated on rocky islets off the Swedish coasts, first induced Nordenskjöld to consider the subject. He remembered a remark of his late father, our former corresponding member, Nils Nordenskjöld, that salt water never penetrated into the Finnish mines situated on the coast and extending under the sea, although the mines were always more or less leaky—what the miners called *vattensjuka* (literally, "water-sick"). He also remembered an observation he himself made during his expeditions to Spitsbergen in 1861 and 1864. It is to be found in his 'Sketch of the Geology of Spitsbergen' (Stockholm: 1867), and is as follows:—

"The strata of the mountain limestone, which at Hinlopen strait alternate with plutonic rocks, are almost horizontal; but the tertiary beds at King's bay and Cape Staratschin are, on the contrary, quite folded, although no eruptive rock could be discovered in the vicinity. There must consequently be some other reason for the folding which occurs in these places; and it appears to me that too much importance has been generally ascribed to the influence of eruptive masses in

connection with the folding, upheaval, and dislocation that is almost everywhere observed on the Earth's crust. As is the case with

BORING AT DALBYÖ.

innumerable other geological phenomena, this also very likely results

less from any violent revolution than from some almost imperceptible but nevertheless continually operating power. The upper part of the Earth's crust is, of course, subjected to periodical variations of temperature, which, at Stockholm for instance, at a depth of 70 or 80 feet rises to 0·01° C. If the Earth's crust were continuous, and the change of volume caused by these variations of temperature did not exceed the limits of elasticity of the rock, they would not exercise any disturbing influence. But as, to a greater or less degree, there are clefts and fissures in all mountains, these will widen in a lower temperature, but become narrower as soon as the temperature rises. If, however, as may often be the case, the fissures when enlarged by a lower temperature are filled up either with chemical or mechanical sediments, a powerful lateral pressure will naturally ensue when the temperature again rises and extends the rock; and thus every variation of temperature will cause a slight dislocation of the strata. When we consider that this agency is working from year to year in the same direction, and that the extensive movement of many hundred miles of the Earth's crust may only cause folds at some narrow spot where the resistance is at a minimum, it should not surprise us to find even the newest formations greatly folded, while older formations in the vicinity may be quite undisturbed."

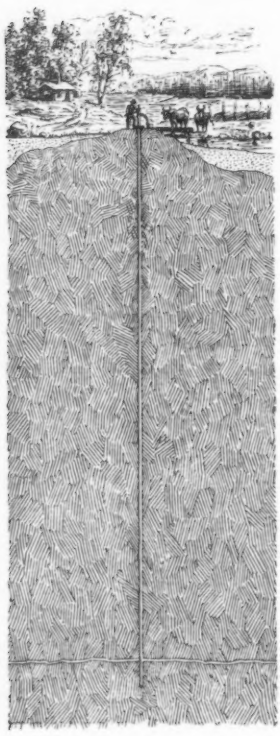
If this remark was correct, Baron Nordenskjöld argued that a horizontal crack would generally exist in all solid rocks at an insignificant depth beneath the Earth's surface. Consequently, in the Swedish rocks, he concluded that water would be found by boring to this crack. But the only places where there was any prospect of such borings being undertaken were on the out-of-the-way rocks and islets, where water was so much needed.

In order to obtain data for solving the problem, Baron Nordenskjöld had, as early as 1885, instituted inquiries respecting the saltness of water in wells or mines near the sea-coast, and he collected some important information. He was told that several wells, in sedimentary strata, in the vicinity of the sea-coast, yielded water free from salt, notwithstanding that the springs are at a depth of 30 to 75 metres below the sea-level. As a curiosity, it may be mentioned that a well that was bored in loose sedimentary strata at Kungsbacka gave a plentiful supply of water, that rose 3 to 4 metres above the sea-level, but this water was salt.

The information thus collected, though far from conclusive, appeared to point to the fact that water obtained by boring on rocky islands should not be salt or brackish, but fresh drinking-water. Nordenskjöld, therefore, proposed to the Chief of the Pilot Stations that he should allow an attempt at boring in the given direction to be made at some suitable station. In consequence of this suggestion, the first boring, with this object, took place in 1891, on the little island of Svangen,

south of Kosterfjorden. It was abandoned, after reaching a sufficient depth, because a long crack was arrived at extending from the sea to the boring-hole. The locality had not been selected by any one conversant with the subject.

After this failure the question was allowed to rest for some years. It was next taken up by Baron Ruuth, the General Director for Pilots, who, regardless of the unsuccessful boring at Svangen, caused a second experiment to be tried at Arkö, beyond Braviken. This time the work was superintended by men who understood it, namely, the baron's son, Gustav Nordenskjöld, the geologist Svenonius, and director Casselli. It was in May, 1894. The site selected was a flat place near the pilot station, the rock being composed of hornblende, gneiss, and diorite. The results were very satisfactory. As soon as a depth of 35 metres was reached, they came to excellent water, yielding 450 litres an hour. The boring-hole had a diameter of 64 mm. At first the water was a little yellow, owing to the clay in the cracks of the rock, the stone-dust, and oil from the boring, but it soon became perfectly clear.



SPRING REACHED BY BORING THROUGH ARCHAIC ROCK.

Water has always been found at a depth of 30 to 35 metres, and similar borings have since been carried out successfully at forty-four different places. At first the water is mixed with the clay from the cracks, the stone-dust, and the oil from the machine, and it is some time before all dirty water is pumped away; but soon it becomes as clear as crystal. At Stockholm it has a temperature of 6° to 7° C. (about 43° to 45° Fahr.); at Gelliavaara, 13° C., or 55° Fahr.

The boring in hard close rock would have the same results in other countries besides Scandinavia. Baron Nordenskjöld is convinced that wherever hard, close rock exists, with variations in temperature and not permeable, water will be found in the same way as in Sweden, and in the same quantity, that is, from 500 to 2000 litres per hour, with moderate pumping. Sites for such borings could be found, for example, in many parts of the north coast of Africa, in Abyssinia, in South

Africa, in Spain, and other parts of the Western Mediterranean, at the foot of Mount Sinai, in Greece and Asia Minor, and in the dry watersheds of the cañons of Colorado. In the tropics, where there are dry and rainy seasons, such wells cannot supply water for extensive cultivation. But they will spring forth, free from all bacteria and impurities, and will suffice for household purposes, for small villages, and for gardens.

The practical importance of Baron Nordenskjöld's discovery for the geographical pioneer, and its interest from the point of view of physical geography, entitles it to the special attention of the readers of this *Journal*.

MR. FITZGERALD'S EXPEDITION TO ACONCAGUA.

By EDWARD A. FITZGERALD.

As I have now brought my expedition to the Cordilleras to a close, I take this opportunity of forwarding a few short notes upon the work done.

We arrived in Buenos Ayres on November 9, and from there proceeded to Cordoba in order to test our instruments at the observatory. Our porters and all the provisions and baggage were sent forward to Mendoza, orders being given that the men should prepare themselves for the hard work in the mountains. We reached Mendoza on December 1, and, after being somewhat delayed by the necessity of buying and hiring mules, we started for Punta de las Vacas, the last station on the Trans-Andine railway, on December 6. It was here that our work in the Cordilleras commenced.

After a journey to the head of the Vacas valley, in order to discover whether there was any possibility of ascending Aconcagua from the eastern side, and a rough survey of the valley itself, we moved higher up the main valley to the Pente del Inca. The Horocones valley, running north-west from the Inca, was at once investigated; and as we found that we could best attack Aconcagua from this valley, we made Inca the base of our operations. We worked in this valley, off and on, for five months, and it was from this point that we made our measurements for the height of Aconcagua. This we did by taking a series of levels from the Vacas railway station to the mouth of the Horocones valley.

From this junction of the two valleys we measured the elevation angles of the mountain with great care, and then made a traverse of the valley on the bar-subtense method, working with a 6-inch theodolite, and checking all our measurements twice. By this means we ascertained the exact position of the mountain with reference to our fixed point at the mouth of the Horocones valley. We also measured the altitude

of the mountain from each station of the traverse. As yet we have not worked out the altitudes given from each station; but, after working out separate altitudes given from five distinct stations, all being several miles from each other, we found that we had not got an error of over 100 feet. The result of these observations gives a trifle over 23,000 feet as the height of Aconcagua.

Our hypsometrical results led us at first to believe that the mountain was 24,000 feet, and our aneroids played us some very curious tricks. One of them, on being taken to the height of 19,000 feet, registered 12 inches and then broke. Others got quickly out of order on being taken above 17,000 feet, but after a few days in the valley became fit for use again.

From our mountain station near the Inca we took a series of observations for the latitude and longitude by circum-meridian observations with both sextant and theodolite, and also a series of lunar distances with the sextant and lunar zenith distances with our theodolites. Thus the position of Puente del Inca and of Aconcagua were clearly ascertained.

The principal instruments used in our survey work were — two 6-inch transit theodolites, one 5-inch, one 3-inch, and a 6-inch sextant, while prismatic compasses were used for rough work in climbing. A telemeter gradient-level and four-metre staff was used for the levelling from the railway. The plane-table was also much used for sketching in detail.

Numerous photographs were taken, and many ornithological and zoological specimens collected. Our photographic work was done with a full-plate camera, from which we have about three hundred results, and quarter-plate for high mountain work. Cycloramic views were taken from various trigonometrical stations and high points to the extent of some 60 yards of film. The Lee-Bridges surveying camera was also used.

Four important mountains in all were climbed by the expedition, besides various smaller peaks incidentally ascended for trigonometrical and prospecting purposes. Three of these mountains were ascended by Mr. Vines, and one by Messrs. Lightbody and Gosse. Mr. Vines ascended Aconcagua and Tupungato, and a mountain some 19,000 feet in height, adjacent to Aconcagua, unnamed. The mountain climbed by Messrs. Lightbody and Gosse was lower down in the Horocones valley, and some 17,000 feet in height.

Our work was brought to a close in the beginning of June, by the heavy winter snows falling earlier in the year than usual.

GEOGRAPHY AT THE BRITISH ASSOCIATION, TORONTO, 1897.

THE success of the meeting of the British Association in Canada is not to be gauged by the number of members in attendance, which was comparatively small. Of those present, however, a much larger proportion than usual was composed of active members who took part in the proceedings of the sections. A large number of British visitors made the journey to Canada, including several who had been present at the Montreal meeting of 1884. The authorities of McGill University, Montreal, gave a very hearty welcome to the members arriving in the Allan line steamer *Parisian*, on which most of the sectional presidents and officials travelled. This was a foretaste of receptions in many towns; and the feeling that the Dominion of Canada as a whole welcomed the Association made itself felt everywhere.

The meeting was opened in Toronto on Wednesday, August 18, by a formal afternoon reception in the Horticultural Pavilion, presided over by the mayor, and open to the public. Several speeches were made, and this innovation seemed to produce an excellent effect, by letting the townspeople feel that they had all a part in receiving the Association.

The sectional meetings were held in the fine buildings of the University of Toronto, Section E—Geography—being housed in the University library. The large reading-room was prepared at great labour and considerable expense as a lecture-room, provided with a powerful electric lantern and all possible appliances, the utmost credit being due to the Toronto committee for the successful efforts they made to provide accommodation of the most convenient possible kind.

The section was constituted as follows:—

President—J. Scott Keltie, LL.D., SEC. R.G.S.

Vice-Presidents—Rev. President Burwash; E. G. Ravenstein; Prof. A. Penck; F. C. Selous; Coutts Trotter.

Secretaries—Colonel F. Bailey, SEC. R.S.G.S.; Dr. H. R. Mill (Recorder); J. B. Tyrrell.

Committee—Prof. Marcus Baker; W. M. Beaufort; Dr. W. T. Blanford, F.R.S.; Rt. Hon. James Bryce, M.P.; Prof. W. M. Davis; Prof. R. E. Dodge; Dr. H. O. Forbes; General A. W. Greely; Otto J. Klotz; Prince Kropotkin; G. E. Lumsden; Prof. John Milne, F.R.S.; Prof. Willis L. Moore; E. Delmar Morgan; Sir G. S. Robertson, K.C.S.I.; A. Laurence Rotch; Sir John Swinburne, Bart.; J. White.

Altogether thirty-three papers and reports were presented, and the section met on five days. It was a matter of regret that the only Canadian Geographical Society, that of Quebec, was not represented at the meeting, especially as it has recently published a volume of

transactions, inaugurating, it is to be hoped, a period of renewed activity in its history. Several papers of great interest were presented by Canadians, and a special feature of the meeting was the participation of a number of the eminent geographers of the United States, and the communication of valuable reports from what may for the moment be termed the geographical departments of the Governments of Canada and the United States. The various subjects under discussion are enumerated below, and fuller details of most of the papers, with the complete text of some, will duly appear in the *Journal*.

Thursday, August 19.—The President's address, delivered at twelve o'clock so as not to clash with Dr. Dawson's address to Section C (Geology), was listened to by a large audience, who highly appreciated the series of maps shown by the electric lantern as a summary of its main features. The address is printed in the *Journal* for September, p. 308. A vote of thanks was proposed by President Burwash, and seconded by Mr. Ravenstein.

Sir G. S. Robertson gave a paper on Kafiristan and the Kafirs, which was perhaps the most popular of those read to the section, if one might judge by the large audience with which the hall was crowded.

Mr. Ravenstein presented the Sixth Report of the Committee on the Climatology of Africa, the main features of which will be recorded in the *Journal*.

Mr. Delmar Morgan described the recent work done by Russians on Novaya Zemlya, referring especially to the recent expedition of Chernysheff. The results ascertained are that the views of von Baer and other earlier explorers that Novaya Zemlya is geologically connected with the Pai-hoi are correct only as regards the southern part and Vaigats; the northern part of the southern island, including both sides of Matochkin strait, show a north-westerly strike of the strata, therefore corresponding, not with the Pai-hoi, but with the Ural. The folding process in Novaya Zemlya coincided with the Palæozoic epoch, and from that time denudation forces have been at work. In this way the system of cross-valleys has been developed and the well-known Matochkin-shar formed. The glacial period in Europe was contemporaneous with that of Novaya Zemlya. This was followed by its submergence beneath the ocean, together with vast tracts of Northern Europe, Asia, and America. This submergence reduced the extent of the glaciers in the north or mountainous region, entirely obliterating them in the south, while the formation of deltas dates from the same period. Novaya Zemlya is now undergoing a new process of glaciation, which will convert it into an icy wilderness.

A paper by Mr. Leigh Smith was communicated, in which he recalled the circumstances of his first arctic voyages, when in 1871, 1872, and 1873 he cruised round the coasts of Spitsbergen and made numerous

temperature observations, discovering the fact that the water at a considerable depth was warmer than that near the surface.

Friday, August 20.—Prof. R. E. Dodge read a suggestive paper on Scientific Geography in Schools; and the Report of the Committee on Geography Teaching in the British islands, drawn up by Mr. A. J. Herbertson, was submitted to the meeting. A short discussion on educational geography followed.

Colonel Bailey read a paper on Forestry in India, in which he sketched the growth of the present system of forest conservation as practised there, and explained the special dangers which have been successfully guarded against, concluding by pointing out the great importance of placing the forests of Canada under a similar administration.

Dr. H. R. Mill suggested a scheme for the classification of geography primarily for bibliographical purposes, the details of which will appear in the *Journal*. A lively discussion followed, in which General Greely, Prof. Davis, and others took part.

Mr. Vaughan Cornish presented a most valuable contribution on the Distribution of Detritus by the Sea, in which he treated the question of the movement of gravel and sand by water in a manner similar to his recent discussion of the movement of dry sand by wind (see *Journal*, 1897, vol. ix. p. 278). The complete paper with illustrations will shortly be published in these pages.

Prof. Milne, F.R.S., gave an account of submarine changes involving earthquakes, and insisted on the importance of establishing seismological stations in all parts of the world.

The work of the day concluded with the reading by Mr. Ravenstein of an important historical paper on the explorations from the Congo to the Cape of Good Hope between 1482 and 1488, containing the results of some recent discoveries amongst old maps which throw fresh light on the character and attainments of Martin Behaim.

Monday, August 23.—The whole of this day was devoted to papers on the North American continent, most of which we hope ultimately to publish in full. At present it is sufficient to record the authors and titles: Prof. Marcus Baker on Institutions engaged in Geographical Work in the United States; Prof. F. H. Newell on the Hydrography of the United States; Dr. T. C. Mendenhall on the Geographical Work of the United States Coast and Geodetic Survey; Prof. W. Morris Davis on the Coastal Plain of Maine; Mr. C. E. Lumsden on the Unification of Time at Sea; Mr. J. B. Tyrrell on the Barren Lands of Canada; Prof. Willis L. Moore on the Daily Weather Survey of the United States; Dr. Charles D. Walcott on the Geographical Work of the United States Geological Survey; Mr. J. White on the Topographical Work of the Canadian Geological Survey. Prof. Davis, Mr. Lumsden, Mr. Tyrrell, and Mr. White read their papers personally; the others

were kindly brought before the meeting by General Greely and Mr. W. J. McGee, representing the National Geographic Society of Washington.

Tuesday, August 24.—The proceedings opened with a crowded joint-meeting of the sections of Geography and Economics, to hear a paper by Mr. F. C. Selous on the Economic Geography of Rhodesia. At the conclusion of the paper, Mr. James Bryce said that if he differed from Mr. Selous in reference to any of his statements he would hesitate to express his opinions, because of the much greater experience which Mr. Selous had gained in his travels up and down the country from 1872 to 1896. He thought it right to tell the audience that some years ago Mr. Selous had formed a resolution not to kill more wild animals than necessary for the safety of life. This resolution was, he thought, commendable, and he wished others would follow the example, as he regretted that the wild animals which made the African forests and plains so interesting are in danger of extinction. Mr. Selous had justly laid especial stress upon the question of health, which is of vital importance in a country, because without health it would be useless to expect British settlers to go there. He was confident that before long it would be found that at all points 3500 feet above the sea-level the European settler would be able to locate with comparative freedom from fever. He was not without hope that such advance would be made in medical science that malarial fever would be overcome by inoculation or some other means. Regarding the prospective agricultural progress, he agreed with Mr. Selous that for the present at least there is no probability of that country exporting grain, although it may be able to supply all the food required by the people, but when the country has been restocked with, he hoped, a better breed of cattle, it will become a meat-exporting country. When the gold-mines run out, as they will probably do within thirty years, a very great stimulus will have been given to progress.

Mr. J. L. Myres gave an account of his recent journey in Tripoli, in the course of which he was led to form an opinion as to the age of the ancient buildings differing from that held by Mr. Cowper.

Prince Kropotkin read a valuable paper on the Prevailing Directions of the Mountain Ranges in Asia, and Prof. Penck discussed the importance of Potamology (the science of rivers) as a branch of geography.

Mr. E. L. Corthell sent a paper on the Geographical Development of the Lower Mississippi. Mr. Otto J. Klotz gave an interesting and well-illustrated discourse on Alaska, exhibiting the photographic surveying instruments used in the survey of the boundary. Prof. H. B. Dixon, F.R.S, who had just returned from a mountaineering trip in the Selkirks, announced his ascent for the first time of Mount Lefroy and another summit which he named Mount Aberdeen.

Mr. O. H. Howarth concluded the proceedings of the day with a paper on Mexico felix and Mexico deserta, terms which he applied to the southern cool and fertile, and to the northern hot and arid, divisions of the Mexican plateau.

Wednesday, August 24.—The section met in the forenoon, when General Greely read a paper by Mr. Henry Gannett on the Material Conditions and Growth of the United States, illustrated by an extensive series of statistical maps and diagrams.

Dr. H. R. Mill, speaking on Geographical Pictures with lantern illustrations, said that, in view of the prominent place now taken by photography in the work of all travellers, it is necessary to urge the importance of taking pictures which are geographically as well as photographically "good." Such pictures must be truthful and representative, the utmost care being taken to avoid distortion, to supply some indication of scale, and to bring out the characteristic features. General views comprehending a considerable area are desirable for showing types of land-forms or sites of towns. Pictures on a larger scale are desirable for showing the detail of special features, such as varieties of architecture, means of transport, or agricultural processes related to certain geographical conditions. As far as possible, every geographical picture should show something distinctly illustrative of a natural feature or a local condition peculiar to the place where it was made, or at least characteristic of it. The handsomest house in a village, the rarest foreign tree in a park, or the prettiest view in a district, represents the sort of subject most often photographed, and they are precisely those of least geographical value.

Prof. Penck followed with a demonstration of school wall-pictures, illustrative of typical geographical features.

Prof. W. M. Davis, in a brief address, urged the importance of Geography as a subject of University Study, and outlined his method of treating geography as a means of higher educational training.

The usual votes of thanks brought to a close a meeting of great interest, during which numerous subjects had been treated of in a manner at once more scientific and more concise than has usually been the case in the section.

Many papers bearing closely on various branches of Physical Geography were read in other sections, the enumeration of which may be useful.

Section A, *Mathematics and Physics.*—Report of the Committee on Seismological Observations; Prof. A. Johnson on a Canadian and Imperial Hydrographic Survey; Mr. J. Hopkinson on Monthly and Annual Rainfalls in the British Empire, 1877–1896; Prof. Van Rijckevorsel on the Temperature of Europe; Prof. R. F. Stupart on the Climatology of Canada; Mr. F. Napier Denison on the Great Lakes as a Sensitive Barometer; Dr. J. Edkins on the Slow Refrigeration of

the Chinese Climate; Prof. Percival Lowell on Atmosphere in its Effects on Astronomical Observations.

SECTION C, *Geology*.—Mr. J. C. Branner on the Former Extension of the Appalachians across Mississippi, Louisiana, and Texas; Report of the Committee for the Investigation of a Coral Reef; Prince Kropotkin on the Asar of Finland; Dr. G. K. Gilbert on Niagara Falls; Mr. J. B. Tyrrell on the Glaciation of North Central Canada; Report of the Committee for collecting Photographs of Geological Interest; and a joint discussion with Section H on the First Traces of Man in America.

SECTION D, *Zoology*.—Prof. Herdman on the Plankton collected continuously during a Traverse of the Atlantic. On the voyage of the *Parisian*, Prof. Herdman on one occasion treated the passengers to a plankton-stew, made up of the minute crustaceans caught in fine silk nets, through which sea-water was pumped continuously, as a demonstration of the unrecognized resources available for the nourishment of shipwrecked crews.

SECTION H, *Anthropology*.—Report on the North Dravidian and Kolarian Races of Central India; Report of the Committee on the North-western Tribes of Canada; Reports of the Ethnographic Surveys of Canada and of the United Kingdom; Prof. Putnam on the Jesup Expedition to the North Pacific, and a Report on the necessity of the immediate investigation of the anthropology of Oceanic islands.

On Saturday, August 21, there was an excursion to Niagara teeming with geographical interest, and on the conclusion of the meeting the Canadian Pacific Railway Company generously provided private cars and free passages for nearly one hundred members of the Association from Toronto to Vancouver and back. The party travelled in three cars on different days, stopping for twenty-four hours at several points, and were assisted in every way possible to form an opinion of the vast agricultural and mineral resources of the Dominion. The trips included a visit to the great nickel-mines at Sudbury, the new gold-fields of the Lake of the Woods, and of the Kootenay district, the coal mines at Nanaimo, and to ranches and experimental farms in several districts. The solid character of the great transcontinental railway, its luxurious equipment, and splendid management, impressed the visitors only less than the magnificent possibilities of the country, and the energy and order of those who are engaged in its development.

THE PHLEGRÆAN FIELDS.*

By R. T. GÜNTHER, M.A., Magdalen College, Oxford.

II.—THE MORPHOGRAPHY OF THE HILLS AND VALLEYS OF CAMALDOLI.

I. Introductory.

The region which is the subject of the present investigation is situated to the north-west of Naples, and occupies the north-east corner of the Phlegræan Fields. The highest point is by far the most conspicuous object in all comprehensive views of the Phlegræan Fields, towering up as it does half as high again as the next highest summit. Perched upon the most elevated part of the hill is the monastery of the Camaldulensian order of Trappists, from whom the hill receives its name of Camaldoli di Napoli.

The entire region is intersected by numerous paths and mule-tracks, which have for the most part become worn deep below the level of the surface of the country, so that the views seen by the wayfarer are usually much restricted. There are good though necessarily indirect roads both from Naples, Pianura, and Marano. Much of the more level ground is devoted to the cultivation of the same crops as are grown in the plains, and vines constitute the greater part of these. About one-half of the entire surface, including most of the steeper slopes, is covered with woods. In many places the vegetation is so luxuriant that it is far from easy to make out the shape of the terrain. The woods are chiefly composed of chestnuts, which are grown as a crop, their stems being cut at more or less regular intervals. Their mode of growth reminded me very forcibly of the beech copses which clothe the Chilterns in many parts of Oxfordshire, and which are also cut when the trees have reached a certain size. The general type of the vegetation might well cause the stranger from the north to imagine himself nearer his home. Along the sides of the deep-cut paths, and wherever light can penetrate to the ground, flourishes a more lowly but not less luxuriant growth of ferns, butcher's broom, brambles, and genista. In the spring the earth is gay with cyclamens, primroses, periwinkles, and scentless violets, which are replaced later by orchids and lilies. In the moister parts at the bottom of the valleys, the humid rocks give nutriment and support to many species of mosses, ferns, and liverworts.

The shape of this tract of upland may be described as an irregular oval, the major axis of which is about 6¼ miles long, and runs east and west. From the monastery of Camaldoli, built near the extreme south-west corner of the region, the ground slopes away on all sides more or less steeply, down to about the 150 or 100 metre contour-line, below which the slopes gradually subside into the general level of the plain of tufa known as the Terra di Lavoro.

The descent is of a very different character in the different parts. Towards the north the slopes are easy and uniform. From the north-west to the north-east of the monastery the sides of the hill slope away down to the plain, in which lie the villages of Marano, Mugnano, and others, with an incline varying from about 1 in 14 to 1 in 10 to the east. But on the other sides, and especially towards the south and west on either flank of the Pignatiello spur, the descent is abrupt and irregular. It is as much as 1 in 2, or even as 1 in 1·4 in some places (Map VIII.).

The steepest slopes lead abruptly down to the oval plain of the Quarto on the west, to the circular plains of Pianura and Soccavo on the south, and to the

* Continued from p. 435. For General Map (No. 1), see p. 464. On p. 417 of the October number, line 4 from the top, 59 should be 41.

plain of Naples on the south-east. Between or away from these the other slopes are far less steep.

II. Geology of Region.

The broader outlines of our knowledge of the geological structure of the hill of Camaldoli have been sketched by Dr. Johnston-Lavis in his note on the ancient lake of Pianura.

The foundation of the hill consists of a volcanic rock, which is quarried at Pianura as building-stone, and which is known by the name of piperno. Upon this is a coarse breccia ("museum breccia"), composed of a miscellaneous assortment of blocks of lava, tuffs, pumice, and other materials. This underlies a great thickness of a more homogeneous, compact rock—the ordinary yellow tufa of Posilipo, which is capped by the series of beds of pozzolana and pumice forming the upper superficial layers of the hill. The existing topographic detail is sculptured in the yellow tufa and superincumbent pumice beds, and it is owing to the want of coherence of the materials of which these superficial layers are composed, that they offer but little resistance to the forces of denudation, and permit themselves to be carved into the ridges and valleys which are so marked a physical feature of the hill.

In some parts the tufa is traversed by vertical veins of a harder and less easily erosible rock. These veins seem to be of rather a local character, but where they occur they modify the process of valley-cutting, always by checking the rate of erosion, and sometimes by causing the bed to deviate from its natural course.

Their presence in the tufa at San Rocco near Capodimonte has already been remarked by Tenore, whose attention was called to them by Buckland. I have observed these veins in the northern part of the hill traversing the beds of the Vallone di Sagliscendi, Palmentello, and Fontana Maltempo. They extend like dykes in a more or less vertical plane for many yards. Their thickness varies from 3 feet to as many inches, and the same vein may vary in thickness in different parts, but is usually thickest in the middle, thinning out towards the ends until it gradually disappears altogether. Their orientation is generally within 20° of the meridian. Sometimes two may be seen close together, separated by but a few inches of ordinary coarser tufa. Their texture is firmer and more compact than that of tufa.

In order to try to discover the explanation of these veins and of their hardness, I had some thin sections cut, which show that they are composed of the same material as the tufa matrix, but in a far finer state of subdivision. A further proof of their similarity is afforded by the chemical analysis, which my friend Mr. Manley has been good enough to undertake for me.

	Ordinary tufa, Per cent.	Tufa of vein. Per cent.
Solubility in water.		
1. In native state	19·50	19·61
2. After being dried and ignited	3·72	3·81
Loss of weight at 100° C.	7·05	5·53
Loss of weight at red heat	8·73	10·38
SiO_2	54·16	51·05
Fe_2O_3	3·55	4·83
Al_2O_3	17·36	16·86
CaO	3·84	2·31
MgO	1·20	1·41
K_2O	3·48	6·26
Na_2O (by difference)	0·63	1·37
	100·00	100·00

The analyses were made in platinum vessels throughout.

Tenore was unable to perceive the least appearance of infiltration or any line of demarcation between the tuff and the veins, and stated that their composition differed in the absence of pumice fragments and in the finer nature of their grain.

My own sections show a very sharp line of demarcation between the tuff and the vein. An examination of several of the veins has convinced me that the only probable explanation is, that they are the result of fissures in the tufa due to earthquakes, shrinkage, or some other cause. These fissures have become filled with a mud of minute fragments of tufa, washed in by rain-water from the surface or down from the sides of the fissure. The mud became consolidated and hardened to form a rocky vein compacter than the ordinary yellow coarse-grained tufa, which it traverses, by reason of the finer subdivision of the particles of which it is composed.

Cracks in the tuff are not unfrequent, and, when near the surface, often become filled with earth and fragments of sticks and leaves.

III. Distribution and Description of Catchment Areas and their Drainage Channels.

A contoured map of Camaldoli (Map I.) shows that the chief slopes of the hills are of two kinds. Some slopes are like the outer surfaces of cones, others are like the inner surfaces of funnels. The former will be referred to as *cone-slopes*, the latter as *crater-slopes*, in all cases in which the evidence seems to point to their once having belonged to a volcano. The rain-water which flows over the surface of these slopes is carried off by channels, which may be conveniently referred to as *cone-valleys* and *crater-valleys* respectively.

The catchment areas may be very naturally classified according to the slopes down which their drainage channels run, and they will be referred to by the name of the basin which receives their drainage. Of the chief groups of catchment areas, four are drained by crater-valleys, one by cone-valleys; but, owing to the large size of the latter area, and also to the fact that its drainage flows towards two different points of the compass, it will be regarded as two.

The chief catchment areas are—

1. Quarto
2. Pianura
3. Soccavo
4. Naples

} crater-drainage areas.

5. Northern
6. Eastern

} cone-drainage areas.

The crater-slopes face to the west and south, the cone-slopes to the north and east.

The four crater-areas drain into four crater-plains of the same name, and are separated by three short ridges or spurs from another. The Quarto-Pianura ridge is that on which the Masseria Romano stands, and is marked Olmetello Romano * on the older maps; the Pianura-Soccavo ridge is known as the Pignatiello, immediately below the monastery; and the Soccavo-Naples ridge, which is continuous with Posilipo hill, bears the village of Vomero and the fortress of San Elmo.

A noteworthy feature is that crater-valleys differ as regards their distribution from cone-valleys, in that the lines of their courses tend to converge when produced

* Olmetello = elm-wood.

downwards from their source, whereas the lines of the courses of cone-valleys tend to become divergent when traced in the same direction.

Crater-Drainage.

The western drainage is conveyed by a number of channels, either into the Piano di Quarto, or else into the small plain lying immediately to the east of the Cratere di Campana, and between the craters of Astroni and Quarto. These two catchment areas are separated by the ridge of hills upon which the Torre Poerio stands, and they may be conveniently termed the Quarto and the Campana catchment areas respectively.

The Campana area is insignificant. The rain-water mostly runs straight down the very steep slopes, and streamlets do not become sufficiently large to effect land-sculpture of any very considerable relief. In this respect the area is somewhat similar to the sides of the Pignatiello. At present the Campana basin also receives the drainage of the northern slopes of Astroni, the eastern slopes of the Cratere di Campana, and from Torre Poerio. The water all sinks away through the permeable soil, but it is not improbable that, if the land-level were to become lower, a lake might be formed similar to that which once existed on the plain of Pianura.

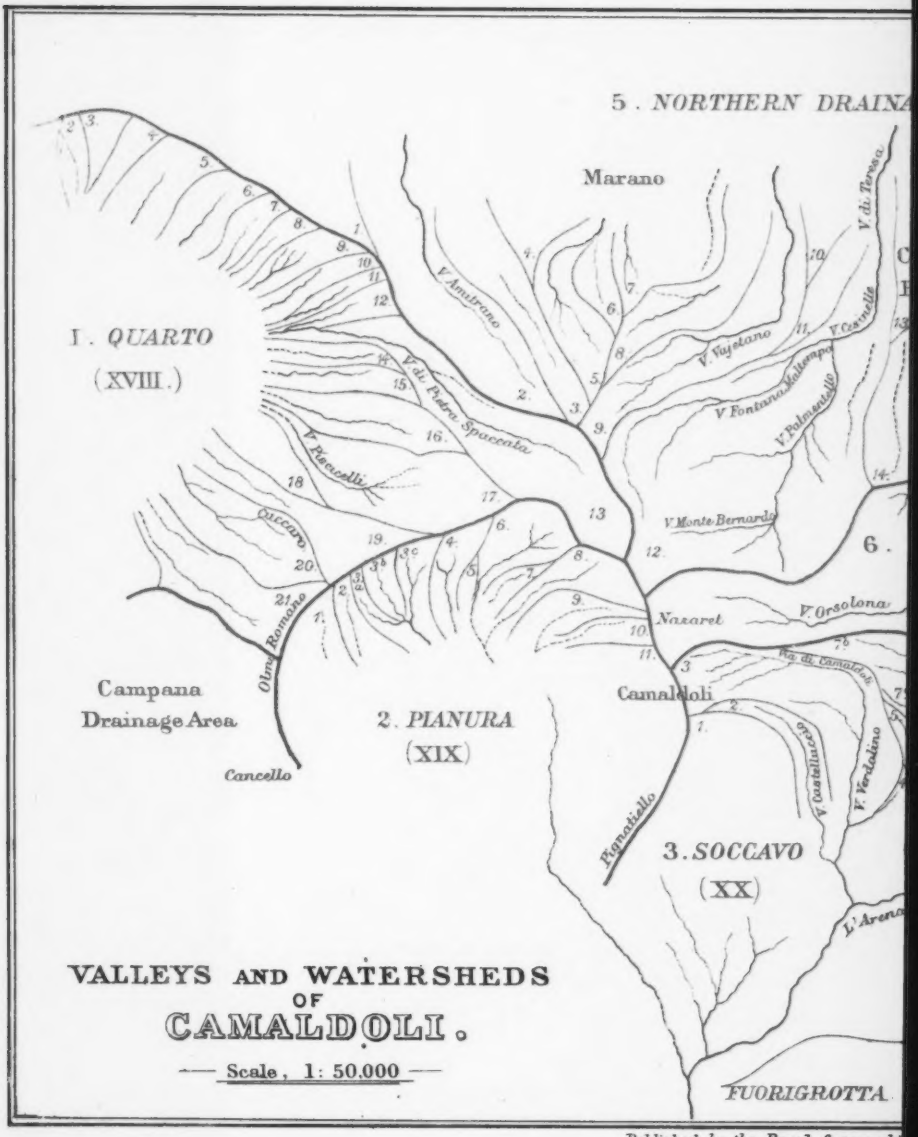
1. *Quarto Catchment Area.*

The eastern part of the Piano di Quarto is cradled in a semicircular amphitheatre of hills—the western rampart of the Camaldoli massif—which are deeply seamed with a system of crater-valleys radiating from the eastern focus of the elliptical Piano di Quarto. The valleys, as is usually the case on steep slopes, for the most part run straight, or, if they branch, the branches tend to run parallel to one another.

At the level of the 100-metre contour-line about twenty-one main valley-beds may be distinguished. The areas drained by these are for the most part very small and of uniform length, with the exception of two. The watershed of the Quarto basin is no further than 1750 metres from the margin of the Piano di Quarto, except at the head of the two valleys, the Vallone di Pietra Spaccata (No. 13) and the Vallone Piscicelli (No. 17), both of which have come to drain larger areas than their neighbours, have cut their beds further back, and have watersheds at a distance of 3500 metres and 2250 metres respectively from the Piano di Quarto. The drainage-area of the Vallone di Spaccata is the largest of the Quarto system, and is remarkable on account of its narrowness as compared with its length. About halfway along its course, near the little chapel of Santa Maria di Pietra Spaccata, the valley scenery is very bold and striking. Vertical rocky walls fall on either side with an abruptness that justifies the name of the valley; below, the torrent bed cannot be descended without ropes, on account of a succession of waterslides and falls.

The watershed between Nos. 19 and 20 is lower near the end at which it joins the main watershed of the Quarto system than nearer the Piano di Quarto. Between these valleys is a conspicuous isolated hill known as the Cuccaro, which probably owes its origin to the valleys on either side of it having widened their beds near their source. No. 21, too, seems to be about to meet the valley on the Pianura side. At present there is only a ridge and a narrow roadway between the chasms with which these two valleys suddenly begin; but in a few years it seems likely that the land upon which the Casa di Gregorio stands will be left as an isolated peak like Monte Cuccaro.

The storm-water which runs down into the Piano di Quarto, and which cannot sink into the soil, is collected into several artificial land-drains, which unite and discharge into the underground tunnel (*Galleria*), which pierces the hills to



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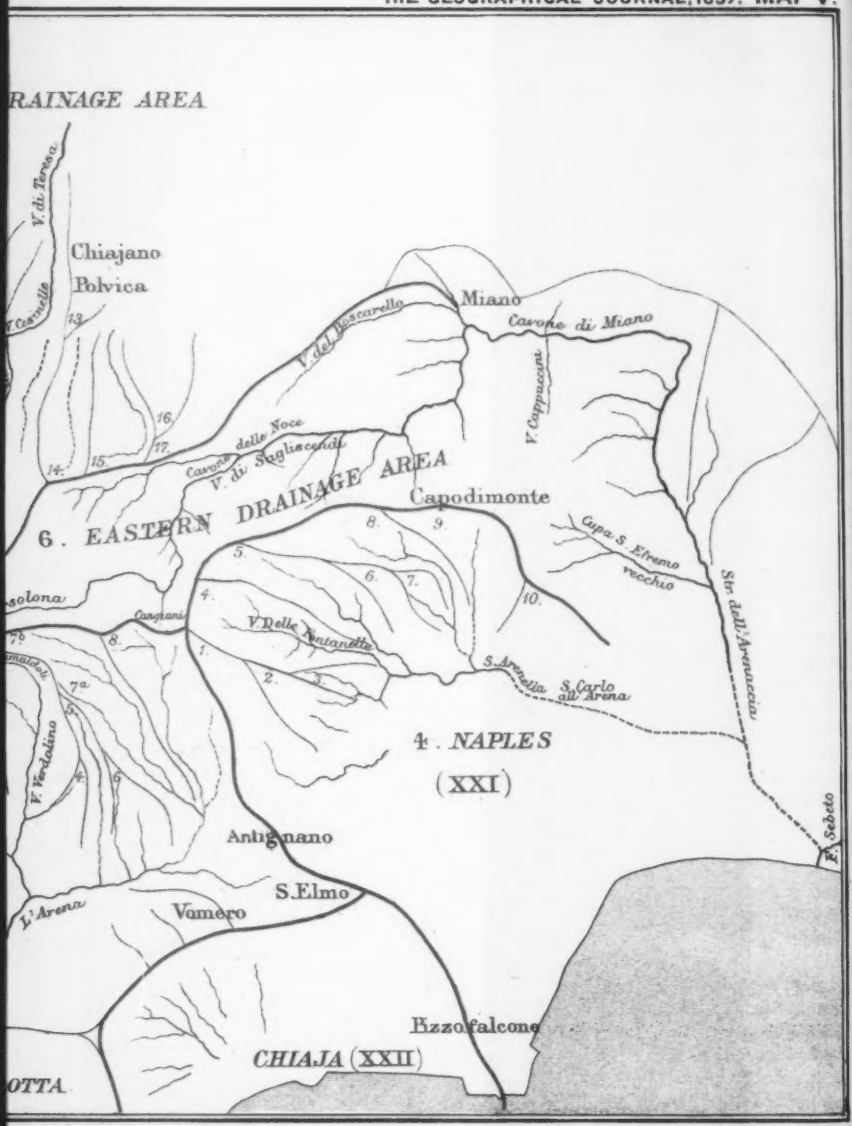

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the west of the Quarto near the Spinelli. The other end of the tunnel opens into the Canale di Scolo. By this artificial channel the Quarto drainage is finally conveyed to the sea near the north end of the lake of Licola.

Before this underground drain was cut, the plain of the Quarto was a marsh during a great part of the year, and was probably covered by a large lake when the ground was nearer sea-level that it is at present.

2. *Pianura Catchment Area.*

The best views of the system are to be had from above the Cancello or from the Pignatiello. The catchment area is a semicircular basin forming part of an almost circular crater 3 kilometres in diameter, whose centre lies about 500 metres to the south-west of the church in the middle of the village of Pianura. The walls of this crater reach their greatest altitude in the north-east at Camaldoli (Fig. 10), where their height has, perhaps, been much augmented by ejectamenta from the neighbouring crater of Soccavo. To the west the crater wall becomes lower, and finally breaks off altogether at the Cancello. The southern wall is low (50 metres above the plain), but quite easily recognizable. It has been suggested that it was levelled by the removal of matter from its south side by marine erosion when the level of the Phlegræan Fields was lower. None of the valleys have encroached perceptibly on the adjacent areas, with the exception, perhaps, of No. 6.

Eleven drainage-areas are distinguished in Map V. A channel in area No. 1 is rapidly cutting its way back, and shows every sign of meeting Quarto valley No. 19, from which it is now only separated by the width of a road. Parts of No. 11 area, on the west of the Pignatiello ridge, are precipitously steep in places; the rest is overgrown with chestnut woods. The rain-water runs straight down the hillside in channels, which are very small and very numerous. Erosion appears to be going on over the entire surface, and to be removing the entire face rather than to be acting with greater effect along certain definite lines.

At the bottom of the slope is a trench into which the storm-waters flow, and by which they are conveyed out of the plain of Pianura.

The general character of the Pianura slopes is that they are much steeper in the middle than either at the top or bottom. Were a transverse section cut across the slope below the monastery, it would be seen to be markedly sigmoid f. This is due to the fact that the upper slope is composed of loose volcanic ash of insufficient cohesive power to form a long steep slope of a stable character, whereas the precipitous middle portion is composed of compact yellow tufa. The lower concave slope is a talus slope, due to the weathering of the surfaces above.

Owing to the fact that the wall of the Pianura crater is higher to the east at Camaldoli than to the west at the Cancello, the valley beds and ridges between them exhibit a marked curve from east to south in their downward course. They all trend towards the higher ground when traced upwards to their sources, involving a change of direction of almost 90° in some cases (Nos. 6 and 9).

3. *Soccavo Catchment Area.*

The Pignatiello ridge (Fig. 10) is the western watershed of the Soccavo area; the eastern watershed is formed by the high ground running from Li Cangiani to St. Elmo and the hill of Posilipo. The Soccavo catchment area, like Pianura, is regarded as the inner slope of a crater, the southern parts of which may have been washed away by the sea. It is possible that the spur of the Posilipo ridge to the north of Fuorigrotta and west of the Villa Patrizi may be a part of the southern wall of the crater of Soccavo.

The valleys which furrow the slopes above Soccavo have cut their beds very deeply into the tufa. The descent to the plain of Soccavo is very steep in places, and the valley cuttings are especially bold.

Of the Soccavo valleys, the most typical are the Vallone Castelluccio (No. 2) and Vallone Verdolino (No. 3). Both take their rise just below the monastery, and run east for some distance; then they turn at right angles to their first direction and run south. The upper portions of the valleys are V-shaped, with sloping tree-clad banks of pumice and ashes. The lower portions have been deeply cut into the solid tufa, and are Y-shaped in transverse section. The tree-clad slopes above, and the almost vertical tufa cliffs below, are well shown in Fig. 12. All the valleys discharge into a watercourse, "l'Arena," which crosses the Soccavo plain, and receives contributions from the western slopes of the Vomero and Posilipo.

A noteworthy feature of the Soccavo valleys is that those which reach the principal watershed (Orsolona-Soccavo watershed) run parallel to it from west to east, away from the Pianura crater. They then veer round to the south, and

Posilipo ridge.

FIG. 12.—VALLONE VERDOLINO, JUST BEFORE REACHING THE SOCCAVO PLAIN.

plunge straight down the steep inner wall of the Soccavo crater. In fact, they at first seem to run down an external slope of the Pianura cone, and then to be diverted into the crater-slope of Soccavo.

4. *Naples Catchment Area.*

The Neapolitan drainage area lies for the most part on a curved hillside extending, like the auditorium of a vast theatre, from the Li Cangiani St. Elmo watershed on the west to the observatory ridge below Capodimonte on the east. The sides of the hills slope gently down into the plain on which Naples is built, from a height which is never much more than 150 metres. Denudation has consequently not had as great a scope as on the other slopes which have just been described. Moreover, owing to the proximity of the Neapolitan drainage area to a large town, the natural drainage channels have been very seriously tampered with, according as the needs of agriculture or the construction of roads and buildings might require.

The chief of the drainage areas discharge their waters into the channel which

divides the city from Capodimonte. Although modern drainage has diverted much of the storm-waters from their natural course, yet it is interesting to note that the old sandy stream-bed is marked out at the present day by such street and place names as Fontanelle, l'Arenella, San Carlo all'Arena, Strada dell' Arenaccio, which indicate the position of watercourses as clearly as l'Arena does that of the stream-bed crossing the Soccavo plain.

Cone-Drainage.

The system of valleys draining the north and east sides of Camaldoli differs from the other valley systems in one important respect. The northern drainage area is the convex outer surface of a cone standing on its base. The other drainage areas or crater areas are the concave inner surfaces of hollow cones standing upon their apices. The effect of this difference being to cause the lines of the beds of the southern and western valleys to tend to converge when produced downwards, and those of the northern valleys to tend to diverge when produced in the same direction.

The storm-waters from the catchment area of the cone-slopes drain partly into the bay of Naples, partly outside it, so it may be subdivided into two catchment areas of almost equal size. The more northern portion is drained by a number of valleys running northwards; the other is drained by a single valley (Vallone di Sagliscendi), which runs east for a considerable distance, but finally turns south (*cf.* p. 429).

5. *Northern Catchment Area.*

The northern catchment area is about three times as large as any one of the intra-crater areas, but its slopes are far less steep. The surface water runs in a more or less northerly direction along a series of valleys, which discharge on to the flat plain of the Campagna Felice. Much water sinks into the soil; the rest is carried away westwards to Patria by a system of channels, of which the Cavone Grande is the largest. Many of these land drains for storm-water have been straightened and deepened artificially,* with corresponding improvement in the sanitary condition of a district which must have been a marsh during a great part of the year.

The largest valleys, V. Palmentello and V. della Fontana Maltempo, drain a large pear-shaped area and unite to form the V. Cesinelle, which discharges its waters into the Vallone di Teresa below the villages of Chiajano and Polvica. An elevation of the bed of the Vallone Palmentello is shown in Map VII.

6. *Eastern Catchment Area.*

The eastern portion of the cone-slopes of Camaldoli are drained by one large valley and its tributaries. Different parts of this valley are locally known by different names, but the entire system will be referred to here by the name of its most important section—the Vallone di Sagliscendi.

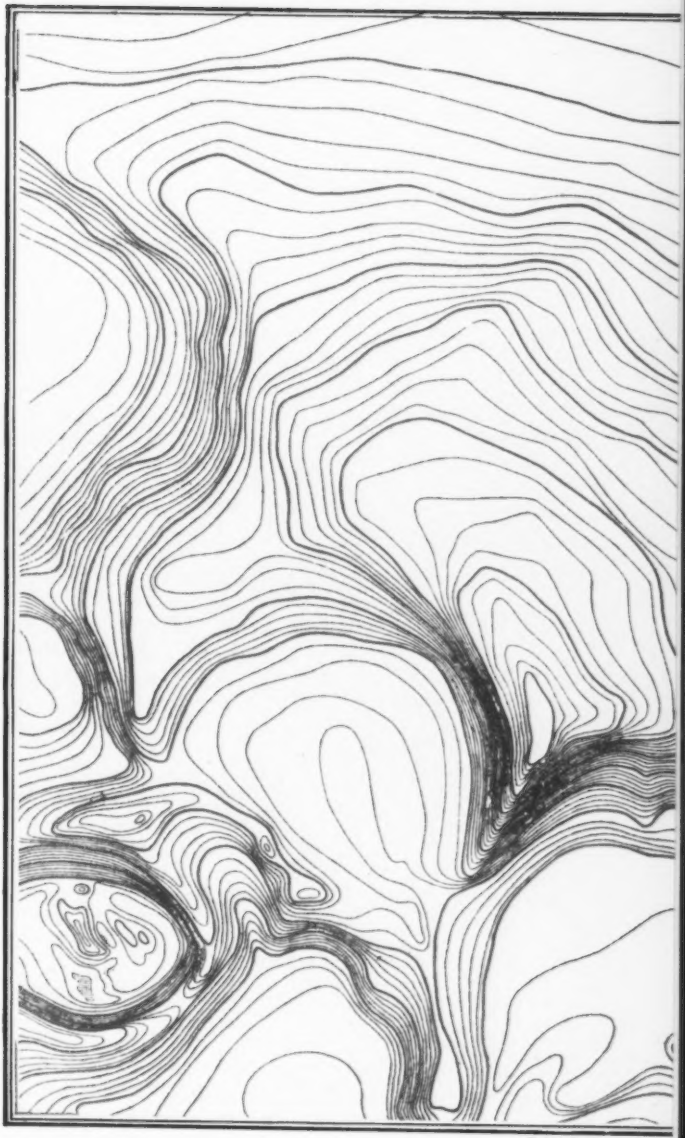
The head of the valley lies close to the village of Nazaret, below which a few small V-shaped valleys run eastwards to the south of Li Guantari, and open into the deeper channel of the Vallone Orsolona, which lies to the south of the Masseria of the same name, and receives all the surface drainage south of the new carriage road from Li Cangiani to Nazaret. At the point where this road crosses, near Li

* Domenico Fontana, the architect, superintended the construction of a system of drainage channels, or *lagni*, extending from the Bocchette di Nola to the Lago di Patria. Carletti estimates the length of the *lagni* at 32 miglia (= 59·3 kilometres), and their vertical fall at 132 palmi (= 34·9 metres). The works were finished in 1612, five years after the death of Fontana.

Cangiani, the valley becomes broader, more open, and less deeply cut. After making two sharp turns to the north, it plunges down into a deep canyon-like cutting in the solid tufa, which is known by the name of the Cavone delle Noce, from the nut trees which flourish in great numbers on the less precipitous upper slopes (Fig. 13). The bed has been cut to a depth of quite 40 metres, and is so narrow that in many places it is impossible for two persons to proceed abreast, and so tortuous that the view along the bottom is interrupted by a turn every few feet. The bed itself is broken by series of small vertical falls alternating with level sandy reaches of greater or less length. Occasionally the *débris* of a landslip from the side blocks the channel, and breaks the velocity of the torrents sufficiently to allow part of their load of suspended matter to be deposited above the obstruction. Some of the larger waterfalls owe their origin to transverse dykes of the harder tufa already described (p. 478), which stretch transversely across the bed, and which are not

FIG. 13.—UPPER SLOPES OF THE CAVONE DELLE NOCE.

quite so readily worn away as the softer tufa. These dykes help to support and preserve the softer tufa above. Below each is usually a depression or pocket in the soft tufa, cut by the force of the water falling vertically from above. Four of these dykes occur in a space of 800 metres, and a little further down, below a transverse wall, the bed has actually been diverted to the north by a large vertical dyke, which forms the face of a high vertical cliff on the right bank. After cutting through this, the valley becomes more V-shaped. Below the Masseria del Principe, the bed has been artificially widened by quarrying operations. At the upper end of the quarry are two more transverse dykes running across in a north and south direction. The lower one, which is probably the one referred to by Tenore and Daubeny in their descriptions of the hard variety of tufa, has been cut away on both sides, leaving a column standing alone just below the entrance of the valley bed into the quarry, and in a line with some enormous artificial caves, from which the tufa is being extensively quarried for building purposes.



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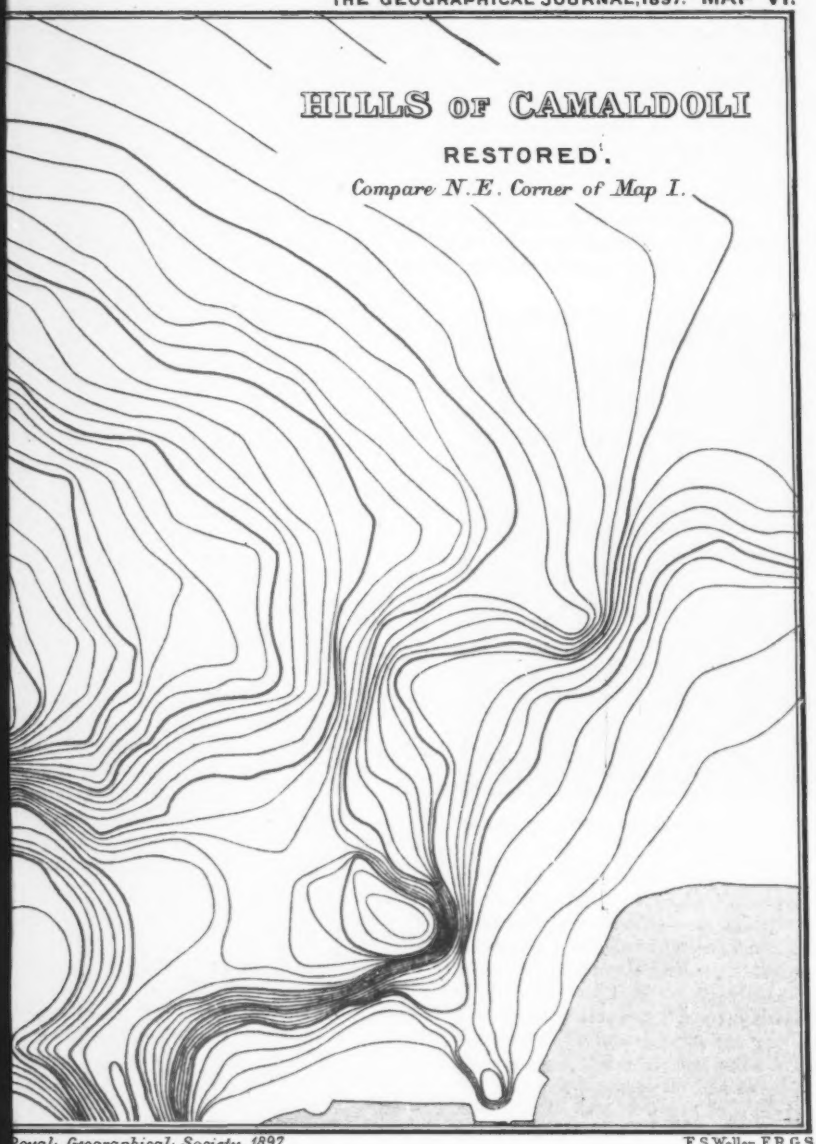


Royal Geographical Society, 1897.

F.S.Waller, F.R.G.S.

Below the quarry the valley changes its character once more, and becomes open and V-shaped in cross-section. At the point where it is spanned by the Ponte di San Rocco it turns north, and after receiving the Vallone del Boscarello, it resumes its eastward course below the north wall of Capodimonte park as the Cavone di Miano. Finally it makes a sharp turn to the south, and soon reaches the plain near the Ponti Rossi. During the last part of its course as a deep valley it receives many tributaries, of which the Vallone Cappuccini, from the northern part of the park, is the most important (*cf.* p. 429).

GRAPHIC AND NUMERICAL REPRESENTATION OF VALLEYS AND CATCHMENT AREAS.

In order to afford a means for the comparative study of the leading features of the Camaldoli valleys and drainage areas, both by themselves and together with those on other volcanic slopes, the appended tables of measurements and diagrams were prepared from the data at my disposal. Inasmuch as many of my own surveys are not in agreement with the Italian Ordnance Surveys as represented in the 1885 map, I believe that there are considerable errors in that map, and consequently both my diagrams and measurements, which are primarily based on that map, must be taken rather as illustrating a method than as being records of the absolute facts.

The numbers in the first column refer to the catchment areas indicated by similar numbers on the map. In the delimitation of these areas, I have, so far as the larger valleys are concerned, limited the area to the region drained by the valley and its tributaries. In many cases, notably on steep hillsides, an area is drained by a multitude of small channels running more or less parallel to one another, and I have thought it best to avoid too extreme a subdivision by making the numbered catchment area fairly inclusive.

The second column gives the sizes in hectares of these arbitrarily numbered catchment areas, measured on a map by Amsler's planimeter. The areas are considered to be bounded by the limits of the adjacent areas, and by the contour-line specified at the head of each table.

In the third and fourth columns are the length and amount of fall of each valley, when straightened out and measured from the source to the contour-line specified at the head of each table.

The valleys shown in the diagrams (Map VII.) were drawn as if their beds ran in the same vertical plane from end to end without any bends. The straightened bed of each was plotted so that each part is represented at its proper height above sea-level, as indicated by the vertical scale. Above this valley-bed line was added a second, the mean bank line, whose vertical distance above the valley-bed line represents the mean height of the banks of the valley above the bed, and drawn to the same scale. In short, the upper line represents the slope of the hillsides, though not always on a regular scale; the lower line represents the bed of a straightened valley. Consequently, the area included between the two lines serves as an indication of the amount of erosion which the stream has effected. For this area I have proposed the term of *erosion area*, although *longitudinal erosion area* would probably be better, and would distinguish it from a transverse erosion area. The last column of the tables gives some of the relative dimensions of the erosion areas of the valleys, plotted and measured with Amsler's planimeter.

In practice the mean bank line was arrived at by the following process. Map VI. was produced from the ordinary contoured map (I.) by the process of "smoothing" out the hollow curves due to valley erosion. This was done by drawing lines ——— across the concavities ⌣⌣⌣⌣ of each contour-line, ⌣⌣⌣⌣ The result is shown in Map VI., which is supposed to represent the shape of the

hill before denudation commenced. Such a smoothed contour-map was drawn on tracing-paper and superimposed upon the ordinary contoured map. The difference of height between the smoothed contour on the tracing-paper and the lowest real

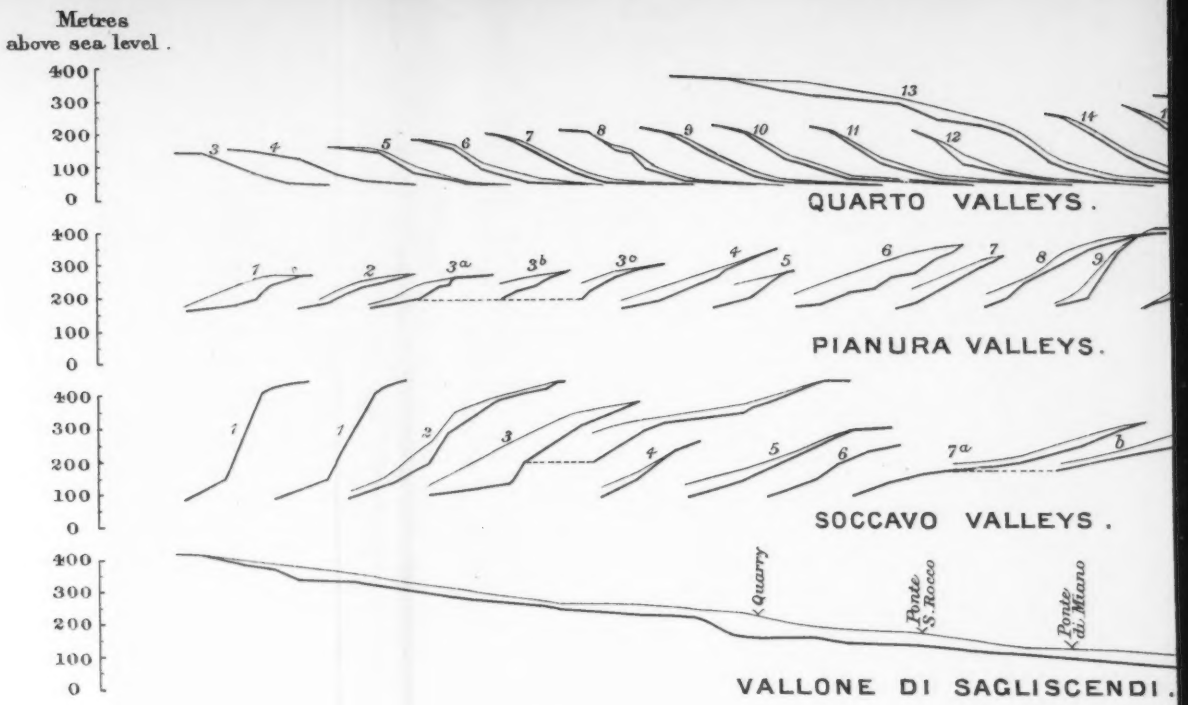
FIG. 14.—BED OF THE CAVONE DELLE NOCE.

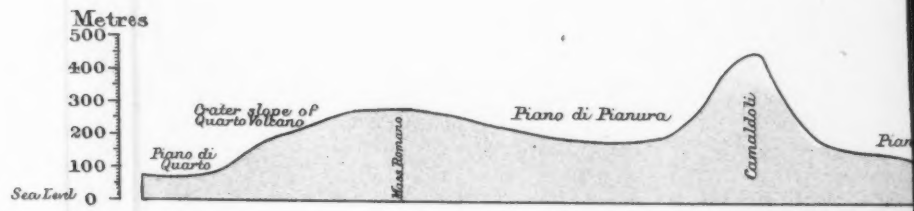
contour-line on the ordinary map touching it was estimated and plotted in the longitudinal valley sections on Map VII. Although a difficult process to describe, it is in fact essentially that employed for finding the depth of a valley indicated in contours.

I.—QUARTO VALLEYS.

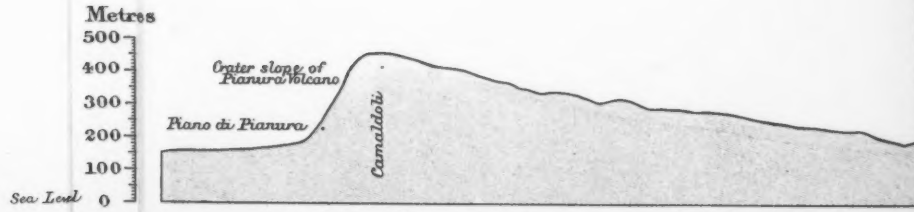
AREAS ABOVE THE 70-METRE CONTOUR-LINE.

No.	Drainage area.	Length.	Fall.	Erosion area.
	Hectares.	Metres.	Metres.	Hectares.
1	3·4	600	80	—
2	4·0	600	80	—
3	8·0	600	80	—
4	8·0	700	80	—
5	22·4	600	90	1·0
6	16·4	600	110	1·1





1. Section from Piano di Quarto to the Riviera di

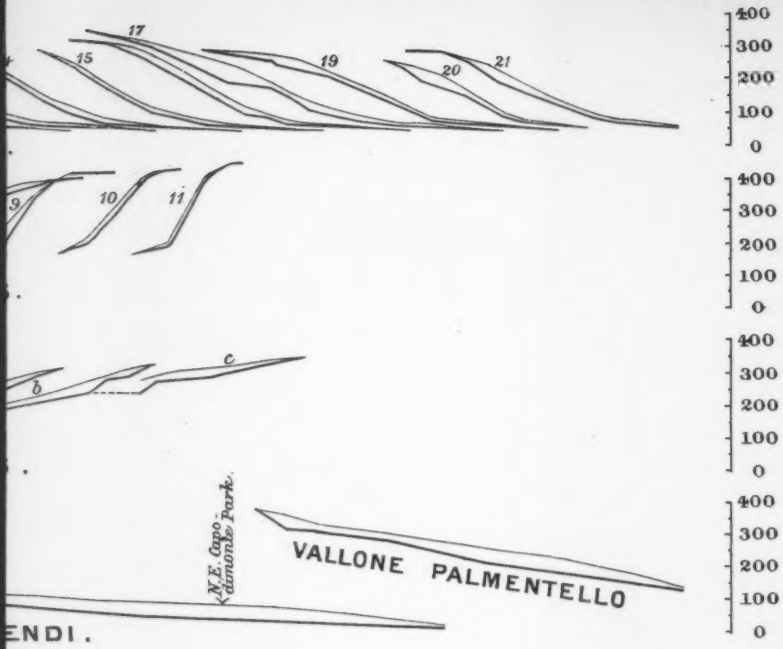


2. Section from Piano di Pianura through Camaldoli

Vertical Scale; $1^{mm} = 20$ metres or 1 : 20,000. Hori

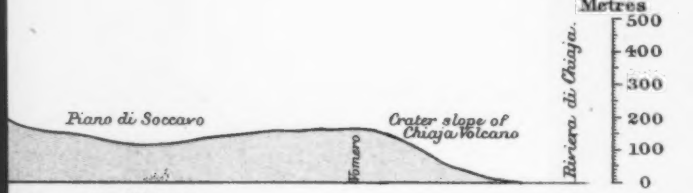
MAP VII.

Metres above sea level.



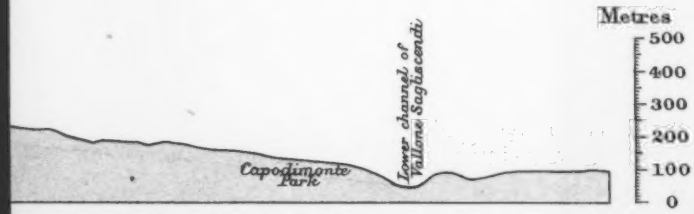
MAP VIII.

Metres



iviera di Chiaja.

Metres



amaldoli to Capodimonte Park.

000. Horizontal Scale, 1:50,000

No.	Drainage area.	Length.	Fall.	Erosion area.
	Hectares.	Metres.	Metres.	Hectares.
7	10·8	600	120	0·6
8	8·8	650	130	0·4
9	14·8	750	150	0·9
10	10·0	750	150	0·7
11	8·2	800	160	0·6
12	10·2	800	160	0·8
13	75·0	3200	320	6·2
14	9·6	800	200	0·7
15	14·6	950	220	1·0
16	27·8	1250	260	2·8
17	53·6	2050	290	5·4
18	16·0	720	140	—
19	28 0	1500	210	2·2
20	34·8	1130	210	1·6
21	39·6	1200	210	2·6
	424·0			

II.—PIANURA VALLEYS.

Areas above the 200-Metre Contour-line.

No.	Drainage area.	Length.	Fall.	Erosion area.
	Hectares.	Metres.	Metres.	Hectares.
1	20·0	400	90	3·0
2	8·8	480	80	1·2
3*a*	4·8	450	80	1·1
3*b*	6·8	420	75	1·3
3*c*	10·2	520	110	1·8
4	11·0	640	160	2·4
5	2·0	280	90	0·9
6	20·8	760	170	6·3
7	4·4	480	140	2·2
8	16·8	1030	200	2·4
9	10·8	690	220	1·7
10	7·2	570	220	0·9
11	45·6	420	250	0·3
	169·2			

III.—SOCCAVO VALLEYS.

Areas above the 150-Metre Contour-line.

No.	Drainage area.	Length.	Fall.	Erosion area.
	Hectares.	Metres.	Metres.	Hectares.
1	40 4	500	300	—
2	13·6	1050	300	4·6
3	58 8	1600	300	—
4	5·6	330	120	0·6
5	12·4	900	160	3·1
6	1·0	00	100	—

Areas above the 200-Metre Contour-line.

7*a*	14·4	1040	130	2·4
7*b*	24·4	1650	150	2·0
8	38·8	900	100	2·4
	220·4			

IV.—NAPLES VALLEYS.

AREAS ABOVE THE 100-METRE CONTOUR-LINE, EXCEPT 1, WHICH IS ABOVE 180 METRES:

No.	Drainage area.	Length.	Fall.	Erosion area.
	Hectares.	Metres.	Metres.	Hectares.
1	32·8	950	90	—
2	28·0	860	160	—
3	6·2	520	120	—
4	36·4	1100	170	3·3
5	30·0	1220	165	1·5
6	12·0	700	100	—
7	5·6	350	60	—
8	30·4	1450	150	2·45
9	24·8	700	90	—
10	7·2	200	50	—
	213·4			

V.—NORTHERN VALLEYS.

AREAS ABOVE THE 200-METRE CONTOUR-LINE.

No.	Drainage area.	Length.	Fall.	Erosion area.
	Hectares.	Metres.	Metres.	
1	10·8	550	20	—
2	62·4	1450	140	—
3	36·8	1475	140	—
4	17·2	500	60	—
5	24·0	1130	130	—
6	10·0	620	110	—
7	28·8	510	100	—
	AREAS ABOVE THE 180-METRE CONTOUR-LINE.			
8	46·0	1430	150	—
9	58·8	1980	170	—
10	6·0	420	30	—
11	14·0	820	70	—
12	197 0	2600	220	—
13 }	32·8	{ 300	20	—
14 }		{ 980	120	—
15	24·8	760	100	—
16	19 6	690	60	—
17	27·6	940	60	—
	616·6			

VI.—EASTERN VALLEYS (V. DI SAGLISCENDI).

AREA ABOVE THE 30-METRE CONTOUR-LINE.

No.	Drainage area.	Length.	Fall.	Erosion area.
	Hectares.	Metres.	Metres.	Hectares.
1	584·2	10,500	400	34

Relation of Drainage Area to Erosion Area.

Among other interrelations exhibited by the numbers expressing the main features of the valleys, there is one which is strikingly prominent in the tables above. It will be noticed at once that the erosion area of a valley stands in a direct and definite relation to its drainage area; in fact, that the ratio of the number expressing the erosion area to the number expressing the drainage area is a constant for the majority of the valleys belonging to the same system.

The chief causes which affect the course and structure of valleys are, the time during which the forces of denudation have been in operation, the inclination of the slope, and the nature of the rock in which the valley has been cut. In the region under consideration, the texture of the rock, apart from local variations, is on the whole uniform, and it seems probable that no part has been subjected to denuding forces longer than any other part.

The chief cause of variation, therefore, is to be sought in the varying steepness of the slopes. Hence it seems probable that the law is true that if *all other conditions, whether of age, rocks, or slopes, are similar, the drainage area of a valley is in a constant proportion to the erosion area.* The ratio of the drainage area to the erosion area may be called the *index of erosion* of the valley.

In the case of the Quarto valleys, the average index of erosion is less than the corresponding index of the Pianura valleys, but this seems to be due to the fact that the latter have on the whole a greater fall in proportion to their length. The Pianura average index of erosion is 5·2,* the Quarto index is 15·4, and the index of erosion of the Vallone di Sagliscendi is 17·2.

IV. Explanation of Structure.

It now remains to inquire into the causes to which the topographical aspect of the region owes its character, and to endeavour to ascertain how far and in what proportion such forces as are at work at the present day have contributed to produce this character.

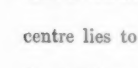
The processes which have co-operated to produce the present configuration of Camaldoli, may, to borrow from the terminology of the biologist, though that terminology might be used more appropriately by the physical geographer, be regarded as anabolic and katabolic. The anabolic processes to which the hill owes its construction are practically dormant at the present day. The katabolic processes, on the other hand, are in full operation, and will in time effect the destruction of the hill.

The method of comparative geology teaches us that the entire massif of Camaldoli is due to a succession of volcanic outbreaks. Each eruption in turn has hurled its contribution of ashes, lapilli, and dust all around the central vent, and has thus built up a more or less circular rampart. Wherever a segment of one such rampart intersected and became superimposed upon some of the ejectamenta from an adjacent vent, a larger mound was heaped up, which, owing to its larger bulk, offered far greater resistance to the wear and tear of katabolic forces than the smaller segments compiled solely from the ejectamenta from a single vent. It is to this intersection and overlapping of the ramparts of *débris* shot out from some of the most productive volcanic vents in the Phlegræan Fields that Camaldoli owes its pre-eminence.

Its original foundations may have been laid by volcanoes of which the walls have become obscured beyond all possibility of recognition, but by far the greatest

* Excepting No. 11, which is drained by many channels.

portion is the result of the accumulation of *débris* ejected from the craters of Quarto, Pianura, Soccavo, and Naples, which, though not the only, are at any rate the most recognizable centres of volcanic activity in this part of the Phlegræan Fields.

The fact that there is a greater accumulation of ejectamenta to the northern side of these craters is partly due to their arrangement in an arc of a circle whose centre lies to the north, thus 

, partly, perhaps, to the erosion of the southern walls of the craters by the sea.

When the shape of this enormous volcanic mass is studied on a contoured map (VI.), on which the bends of the lines representing valleys due to denudation have been filled in as described on p. 486, it will be seen that its general configuration is by no means inconsistent with the view just given. A regular series of contour-lines will be seen descending from the highest point. Their regularity would probably have been marred had there been any comparatively recent volcanic vents further north than those mentioned.

In addition to the contributions from Quarto, Pianura, Soccavo, and Naples, no doubt others have been able to reach it from Agnano, Astroni, Fossa Lupara, and perhaps Cigliano during their more violent eruptions.

Nature of Material—Character of Rocks, etc.

The chief geological formations traversed by the valley systems of Camaldoli have already been noticed; there still remains the consideration of those inherent qualities of soils and rocks which have hindered or favoured katabolic processes.

It has been stated that the hills are composed of a solid tufa basis or core, capped by strata of loose ashy materials. The upper layers consist of alternating beds of loose ashes, pumice, and pozzolana of the most readily erosible kind. The fragments possess no sort of coherence. Their very arrangement in layers of larger and smaller sized fragments is a source of weakness, and the individual particles are so light as to be very easy of transport by running water—many will actually float on water. Owing to this want of coherence, during the heavy winter and autumn rains landslips are of frequent occurrence. As the beds of the water-courses are being eroded, their sides are being undermined, or, at any rate, rendered less secure. Every now and again the cohesive forces are overcome, and the entire bank slides down into the bed of the stream, leaving a bare scar. With the intention of ascertaining the angle of inclination at which a bank composed of loose ashes tends to slide, I measured the inclination of several fresh scars on the sides of the Palmentello and Vajetano valleys, and found that they were all of a remarkably uniform angle. The five measured were 50°, 53°, 53°, 55°, and 57°; the average angle of slip, therefore, being between 53° and 54°.

On the other hand, the open and broken nature of a soil composed of such ashes and pumiceous fragments makes it very difficult for streams to form on the surface, owing to its great absorptive power and excellent drainage. It is only when the ash surface is much inclined or has the interstices between its particles choked by a fine tilth so that its drainage becomes impaired, that rain-water can collect and form streams running on and capable of eroding the surface.

As a result, only the very heaviest of rains produce streams on the more inclined surfaces; but when such streams do form, they wash out channels in the ash beds very readily.

The truth of this is demonstrated when the absorptive power and drainage of the surface is in any way interfered with. In many parts the natural surface is able to get rid of all the rain-water which falls upon it by imbibition. No surface

streams are formed. No drainage channels are eroded. Now, it often happens that when a road is made across such a surface, the part covered by the roadway becomes almost impervious. The rain-water collects and runs along the roadway, forming a streamlet which, striking off, runs down an adjoining slope with sufficient force to cut quite a considerable valley in a short time.

When a drainage channel has once been cut to a certain depth, a stream will flow along its bed after a less heavy shower of rain than is required to make a stream run over the surface; and the deeper a valley bed is below the level of the land, the less rainfall is required to produce a stream in it, for the reason that the good drainage of the ash beds permits the water in them to percolate freely and sink into any drainage channel in the immediate vicinity.

Underlying the ash beds is the more compact tufa. Although far inferior to the ash beds, its absorptive power when dry is very considerable, and it can also imbibe water with great rapidity.

The great porosity of dry tufa may be demonstrated by dropping a piece into water. The water on entering drives the air from the pores of the rock with such vigour as to cause it to hiss or sing like a fluid in brisk effervescence. Hard tufas do not absorb as much water as softer ones, nor do they become completely saturated as quickly. The mean of the results obtained from a number of experiments upon tufa from different localities was that soft tufa absorbed about 22 per cent. of its weight of water when immersed for an hour. Hard tufa only absorbed about 12 per cent. of its weight under the same conditions. It should be stated that no attempt had been made to use chemically dry tufa for these experiments. The blocks had only been kept in an ordinary dry place for some time, and were therefore in a somewhat similar condition to the surface of a tufa rock at the end of the dry season.

In order to form some conception of the rate at which absorption proceeds, fragments of tufa were totally immersed for a short period, and were then taken out and examined. If the surface of the rock appeared to become dry almost directly after its removal from the liquid, it showed that superficial saturation was not complete, and the fragment was immediately plunged into the water for a second period. This process was repeated until the fragment preserved a wet appearance for a couple of seconds after removal from the water. The superficial saturation point was then considered to have been reached. Fragments of about 300 grammes were found to require quite five minutes' soaking before they became superficially saturated as indicated by the above test.

From these experiments it would follow that, unless showers are of phenomenal heaviness, they must continue for a long time before clean dry tufa becomes sufficiently saturated to allow water to run over its surface, even when that surface is inclined at a considerable angle. If the surface is much broken up, the time required for superficial saturation will be greater in proportion as the area of the surface is more extensive.

Unfortunately, my observations on the spot are too incomplete to afford any data concerning the rate of surface saturation during a shower, but I have since conducted a second series of experiments bearing upon this point.

A block of dry tufa with a flat upper surface of 60 square centimetres was placed below an ordinary chemical burette arranged so as to deliver a measurable quantity of water drop by drop on to the surface of the block of tufa. The experiment was conducted so as to imitate a shower of rain, and the block was kept moving so as to prevent two consecutive drops falling on the same spot, and to ensure the even distribution of the water all over the surface. The result obtained from the experiments was, that when as much water as would correspond

to 0·5 centimetre of rain in three minutes had been allowed to fall slowly drop by drop on to the stone, the water was found to have penetrated about 1·5 centimetre below the surface. The tufa, however, continued to absorb water with diminishing avidity until an amount corresponding to 1 centimetre of rain had been delivered. At this point surface saturation became complete, and the water ran freely over the surface.

The conditions affecting the above experiments are, of course, very different to those ordinarily obtaining on the slopes of Camaldoli. The experimental block had a clean, freshly broken surface. If the rocky hillsides were in the same physical condition, it is very doubtful whether streams could ever collect on them at all. The rock faces in their natural state are generally clothed with more or less low forms of vegetation, and their pores are choked with mud and dirt to such an extent that the absorptive power of the rock is far less vigorous than in the case of the experimental block.

As compared with the superincumbent ash beds, the tufa possesses a coherence which makes it more difficult of erosion, but, on the other hand, its compactness impairs its drainage power, with the result that streams begin to form and flow over its surface after less rain has fallen. When dry it possesses a very considerable absorptive power, but its lowlying position nearer the water-level results in its generally holding a large quantity of water absorbed in its pores, and in its appetite for much more being thereby blunted.

In texture it is fairly uniform, but here and there occur local variations of sufficient importance to affect the ordinary course of valley formation. The chief of these are the dykes already noticed (p. 484), which have to some extent diverted streams and retarded the rate of corrasion. The hard inclusions in the lower reaches of the V. Piscicelli must also have a similar action.

Katabolic Agents.

The chief katabolic agents which may have helped to model Camaldoli are marine erosion, rain, frost, heat, wind, and organic nature. Of these, the five latter are all in action at the present day, but it is possible that the waves of the sea took some part in the past.

Sea.—It is possible that the eruption of the Camaldoli volcanoes and the anabolism of the Camaldoli ash and tufa heaps took place beneath the surface of a shallow sea. If this be the true history of the hill, the flanks of the emerging volcanoes must have been subjected to denuding forces of very great power. The irresistible encroachments of the waves of the sea would amply suffice, were a reason demanded for the absence of entire segments of some crater rings or for the broaching of others.

If geologists are unwilling to concede a submarine origin to Camaldoli, they are, at any rate, agreed that at no very distant date the sea covered Bagnoli, washed away the south-western flank of Monte Barbaro, and covered the cliffs of La Starza (Pozzuoli), so rich in recent marine shells. The land must, in fact, have been at least 60 metres lower than at the present, and the entire Bagnoli plain must have been submerged. If it can be proved that the level of the land was yet another 60 metres lower, the powerful waves raised by the scirocco (south-east wind), rolling over the shallows, might easily have levelled the southern walls of the craters of Pianura and Soccavo, have distributed their *débris* over the Bagnoli and Agnano plains, and have then broken against the cliffs below Camaldoli itself.

At the present day the land is high out of the water, and therefore all erosion is subaërial.

Subaërial Erosion.

Rain.—A valuable record of both the rainfall and the rate of rainfall has been kept by the monks at Camaldoli since 1887. From their records it appears that the average rainfall for the years 1888–1895 is about 981 millimetres per annum, or about 135 millimetres *more* than the rainfall down below at the R. Osservatorio di Capodimonte (Naples) during the same period.

It also appears—

1. That the most rainy months are October, November, December, and January, and that of these December has the greatest rainfall.

2. That the average rate of rainfall is twice as fast during the summer and autumn as during the winter and spring. In other words, the months during which the greatest quantity of rain falls are by no means those during which rain falls fastest.

The average rate of rainfall is about 2½ millimetres per hour of rain. The rate is greatest during September and October, when it averages above 4 millimetres per hour of rain, and least during February and March.

It follows, therefore, that the rate of rainfall in the different seasons of the year is such as to have the maximum erosive effect as far as the torrent beds are concerned.

During the dry summer months the ground becomes dried, and acquires increased absorptive powers. When the autumn thunderstorms begin to clear the air, generally about the day of the Festa di Nostra Signora di Piedigrotta (September 8), the rainfall is very fast, and consequently the water has a better chance of forming streams than if the rainfall was slower and the water more likely to be absorbed by the ground.

The surface of the ground having once become saturated, a heavy fall of rain produces most destructive effects. The watercourses are swept by torrents of liquid mud, bearing along sand and stones, which rasp away the surface of the rocky beds, as the numerous scratches on their sides and bottom testify.

On steep slopes with relatively small catchment areas, such as the two sides of the Pignatiello ridge, or the side slopes of many of the deeper valleys, the rain-water runs straight down the slope without cutting channels of any considerable depth, but heavy showers result in the general degradation of the entire face of the slope. If, however, there be a sufficiently large catchment area above the slope, to collect a sufficient head of water, as is the case with many of the Quarto areas, cf. Vallone Pietra Spaccata, etc., deep and straight furrows are cut down the slope.

If the slope be less steep, the valley beds begin to turn first to one side and then to the other. The sides become undermined at the beds, and finally slide down. The final precipitation is often brought about by a sudden heavy shower after the undermining has progressed for a certain distance.

The most striking results of erosion are to be found at the heads of many of the valleys which commence as chasms. Examples are to be found in Quarto No. 21 and Pianura No. 1, and in some of the side branches of Quarto 17, all of which are rapidly working their way backwards towards their watersheds.

Frost.—Another factor which takes part in the work of degradation of the hills of Camaldoli is frost. It might be supposed that frost was a comparatively unimportant factor in Southern Italy, especially so near the sea and at such a low altitude. Nevertheless, the thermometer at the monastery of Camaldoli registered

a temperature below +1° Centigrade on thirteen nights during the winter of 1895-6.*

At all times of the year the temperature of the air in many of the valleys, except when warmed directly by the sun's rays, is much below that of the air outside, on account of the evaporation which is continually going on. I have repeatedly noticed a difference of temperature of 5° C. between the shade temperature at the bottom of the valley and that outside it.

During many nights in the year the effect of evaporation, combined with that of radiation, is to produce a very low temperature. The result may be seen after the winter in many of the valleys the beds of which are hewn in the tufa. The superficial soil and rocks get cooled; the water held absorbed in their pores freezes, and by its expansion scales off large flakes—sometimes as much as 2 inches thick and a foot or two square—from the surface of the porous tufa.

When such flakes become dislodged, their fragments, having slid down to the bottom of the cutting, are rolled along by the next torrent, and assist in rasping away the sides and bottom of the valley bed on their way down.

Heat.—A similar cause of the destruction of rocky surfaces, according to Johnston-Lavis, is heat. When rocks loaded with moisture are exposed to the hot rays of the sun, they become heated up to a very considerable temperature, and the water contained near their surface is converted into vapour, which by its expansion produces a constant crumbling of the exposed face, and prepares the way for the more destructive action of rain or wind.

Wind.—It is probable that wind does not often play a considerable part in the moving of the surface, but there can be no doubt that occasional severe gales, sweeping along the lines of valleys, take a share in the work of the levelling of ridges composed of the looser and lighter materials.

Organic Nature.—The chief factors of inorganic nature at work at the modelling of Camaldoli to-day are almost without exception destructive or katabolic in their action. On the other hand, the action of organic life may be said to be partly katabolic, partly conservative, or in passive opposition to the katabolic forces. On the whole, vegetable life is naturally conservative, animal life naturally destructive, in its action. At the present time, the conservative action of vegetable life far outweighs the destructive action of animal life. An important exception to the general rule is afforded by man, who by civilization has become a conservative rather than a destructive force in this region.

Effect of Animals.—The banks of valleys cut in the materials which compose the upper parts of Camaldoli are often so steep and loosely combined that it needs but a small disturbance to produce quite a considerable fall. Animals are often the cause of such landslips, and goats and dogs are not the least offenders in this respect. The way in which it is possible for quite small animals to start such

* 1895.	November	23	...	+ 0·5 C.	1896.	January	8	...	− 0·2 C.
	December	28	...	+ 0·2 C.		,,	9	...	− 1·2 C.
	,,	29	...	− 0·3 C.		,,	10	...	− 1·3 C.
	,,	30	...	− 0·7 C.		,,	11	...	+ 0·5 C.
1896.	January	2	...	+ 0·5 C.		February	16	...	− 0·2 C.
	,,	6	...	+ 0·3 C.		,,	17	...	− 1·6 C.
	,,	7	...	− 1·0 C.					

The temperatures below +1·0° C. are given, because it is certain that the minimum readings on the same nights would have been very much lower had the instruments been away from buildings.

landslips must be clear to any one who has witnessed a small lizard running up a steep bank of dry volcanic earth, and has observed even its small weight raise quite a cloud of dust and start a miniature avalanche of the larger particles of tufa and pumice.

Effect of Man.—The ash-beds can be eroded with such extraordinary ease and rapidity that mule-tracks and goat-paths may be converted into cuttings of considerable depth by a few showers. Of such deepened paths, sometimes lying many feet below the surface of the country, there are hundreds. Their origin is thoroughly well understood, and is implied in the name *cupa*, which signifies such a deeply cut path. A good illustration of one may be seen in Hamilton's 'Campi Phlegræi,' pl. xl. Road-making in this country is easier than preserving made roads from being washed away. The ease and rapidity with which channels are cut by rain-water is so great that the inhabitants incur great trouble and expense in coercing storm-torrents into other channels than the middle of the roads. It is by his efforts to regulate the drainage and to preserve his paths and fields that man becomes a conservator of the topographical features of Camaldoli.

The methods employed in country lanes are simple. A stem of a tree or a line of masonry is buried transversely or obliquely across the roadway in order to break the force of the currents of water, to divert them to one side, and to prevent them from excavating channels in the roadway itself, as well as to hold the soil above from being washed down. The method is effectual for a while, but requires constant attention, as any roadway which has been neglected for a few seasons will testify.

The traffic along these *cupe* is also an important factor in their formation. The stems of chestnut trees are cut in the woods when they are some 20 feet long. The small side branches are lopped off on the spot, and the poles are tied together so as to form large bundles. Mules are employed for the purpose of carrying these bundles. Each mule carries two, one slung on each side, so that the smaller ends trail along the ground behind. Carried in this way, these large bundles act as enormous brooms which sweep the paths deeper, raising clouds of dust as they go. The banks at the sides of the paths suffer from the frequent brushings of these chestnut poles to such an extent that, wherever it is desirable to preserve them, the landowners embed large stones, which shield the soft banks to some extent.

But it is as an agriculturalist that man is, and is likely to remain, a most important factor in the preservation of the Camaldoli hillsides.

Preparation of Hillsides for the Growth of Vines.—When a steep hillside has been cleared of its natural vegetation for the purpose of viticulture, it becomes necessary to prevent the waters of torrential rains accumulating to form torrents which would sweep away the entire surface soil from the slopes. This is done by the laying out of a system of horizontal terraces traversing the face of the slope at intervals of from 4 to 5 feet. A hillside prepared in this manner looks like a gigantic flight of stairs. The steps, upon the top of each of which a single row of vines is planted, are made so as to slope inwards and catch the rain-water which runs down from the bank above. On a hillside terraced in a proper manner, it is impossible for streamlets to join and become large enough to wash away any very extensive areas of the surface soil.

These terraces for vines (*tappia fossati*) are made by *tappiatori*. The people of Piscinola are considered the best for the work. The best time to begin the work is at the fall of the leaf, when the ground is dry and easily handled. The *fossati* are then laid out, beginning from the bottom and breaking up the earth well (*scasso*), and then planted; but they are not beaten smooth by the mattock (*zappa*), "*cacciare la faccia e fare i colli*," till the spring rains, to avoid the frosts, which cause the

surface to scale. The men usually work in companies of ten or twelve, headed by a foreman called the *caporale*.*

Vegetation.—It has already been stated that large areas of the Camaldoli hills are thickly wooded. According to a rough estimate, at least one-half of the district under consideration is covered with woods, the greater part of which flourish on the steeper hillsides and valley banks. The chief trees are chestnuts, poplars, oaks, hazel nuts, planes, stone-pines, and some others. There are no very big or large trees. The oldest are perhaps the two or three shattered oaks in the monks' garden at Camaldoli, which have so far been spared the woodman's axe, but are severely

FIG. 15.—PATH THROUGH YOUNG CHESTNUT WOOD.
(*After a photograph by Dr. D. G. Fairchild, February*, 1894.)

branded by lightning. By far the greater part of the trees are chestnuts, which are largely cultivated as a crop for poles and firewood.

The method of cultivation as practised consists in the encouragement of the production of many stems from each large root. When these stems have grown to the desired size, they are cut down as close as possible to the root. From around the scars young shoots sprout, which grow into the next crop of stems. An old chestnut root may grow to a great size, and bear perhaps twenty or more stems.

* I am indebted to Mr. Neville-Rolfe for these details.

Its value is estimated by the number of stems it will bear. The crop of poles from these old roots is in many cases considered so valuable, that if such a chestnut root happens to be growing on the side of a cupa, and is in any danger of being undermined by the denudation of the bank on which it is growing, the foresters actually find it worth their while to build a masonry buttress beneath it in order to support it. Along many of the sunk wood paths leading up to Camaldoli there may be seen large trees entirely supported by high stone pillars, and only connected with the bank by a few roots running horizontally from the top of the pillar into the bank, which has retreated from them, but from which they still continue to derive nutriment.

The general effect of vegetation is conservative, inasmuch as it hinders denudation. The chestnut woods of Camaldoli are especially potent in this way, and are therefore of the highest importance as regards the preservation of the topographical aspects of the country. Chestnut trees, in virtue of their spreading roots, are especially well adapted, not only to interrupt rainwater rivulets, but also to bind the soil together, and thus prevent landslips on the steeper slopes. Another way in which chestnut trees hinder denudation is by covering the soil twice annually with hygroscopic layers of decaying vegetable matter. The inflorescences, as well as the leaves, contribute largely to the formation of mould, and vegetable mould is said to be capable of absorbing almost twice its own weight of water.

The importance of a vegetable covering to hills composed of such loose materials as the pumice beds of Camaldoli cannot be too highly estimated, and there can be no doubt but that, if the slopes of the hills were to be entirely deforested and exposed to the unrestrained action of the elements, a change would be produced which could only be properly realized by one who has seen such desolation as that of the weather-furrowed hills of Southern France or Central Sicily, where the storm-torrents find no check to their course of devastation.

V. Description of a Typical Camaldoli Valley.

If a watercourse draining any area on the sides of Camaldoli be followed from its source down to one of the level plains, across which all surface drainage has to pass before it can reach the sea, it will be found that the valley passes through three phases, and that these phases stand in direct relation to the geological structure of the hill.

Phase 1.—The majority of the valleys commence as **V**-shaped troughs in the soft ash-beds near the principal watersheds. On their downward course their cuttings increase in depth quite uniformly, owing to the homogeneity and want of cohesion of the material in which they are excavated. Such increase of depth is in great measure proportional to the catchment area above, and therefore to the size of the stream which runs along the bed after torrential rains. The volume of water in the lower parts of the bed is naturally larger than that in the upper parts, and is therefore capable, *ceteris paribus*, of doing more work. As the bed is deepened the ash-banks soon begin to slide down and become less steep (Landslips, *vide* p. 490). The inclination of the sides of the watercourse is entirely dependent on the relation between the rate at which the bed is being deepened and the rate at which the sides are being denuded.

In exceptional cases a valley bed commences quite suddenly as a deep gully, owing to the very rapid erosion caused by a head of water falling from a height. Such chasms usually owe their origin to some interference with the natural mode of drainage, or to the existence of a harder layer over a softer and more easily erosible one.

When a valley bed deepens suddenly in this way, it is generally **U**-shaped in

cross-section just below the fall. As it draws away from the fall, the sides gradually become inclined outwards, and the section becomes V-shaped, owing to the gradual degradation of their slope by denudation.

The faster such a bed is being cut backwards, the greater the length of the bed with a U-shaped section. The first phase of the valley may be briefly defined as that part which is cut in the loose ash-beds. The rate at which the cutting is deepened does not bear a high proportion to the rate at which the crumbling banks are being "degraded" by denudation. The typical section is V-shaped. The banks are usually wooded or under cultivation.

Phase 2.—Some of the shorter and shallower of the valley beds remain in the first phase throughout their course. The longer and deeper ones usually cut their beds through the superficial ash strata into the underlying tufa rock. When such a valley enters the second phase, the banks on either side of the stream-bed are composed of loose ashes above, solid tufa below, and their inclination is proportional to the rates of denudation of these two materials. If the deepening of the bed has been at all rapid as compared with the degradation of the sides, the tufa banks are very steep, being almost vertical in many places. The ash-slopes have much the same inclination as in the first phase. Consequently the valley assumes the Y-shaped section, so characteristic of the deeper cuttings locally known as *cavoni*.

The character of the stream-bed differs from the stream-bed of Phase 1, inasmuch as it is interrupted by many small falls, which are due to slight local irregularities in the hardness of the rock, and which owe their preservation to the resistent qualities of the tufa. The bed is, as a rule, clean swept. The torrents flow too swiftly to permit detritus to settle anywhere but in the hollows.

Phase 3.—When the streams have reached the bottom of the hill-slopes, they have usually to cross a level plain before they can reach the sea. The rate of fall of a stream running across such a plain is exceedingly small when compared with that of its upper course down the hillside. The result is that the velocity of the streams becomes very much less; they can no longer hold as much solid matter in suspension, and their general character is that of streams which have nearly reached their base-level. They are homologous with the "*lagni*" at the foot of Monte Somma, and their flat sandy beds (*arene*) are often used as lanes.

The different phases through which most of the valleys pass are correlated with the nature of the ground. The upper portions of the watercourses are cut in ash-beds, which afford good drainage and hinder stream-formation, and are but rarely traversed by streams of any considerable size; therefore bed-erosion is but little quicker than the erosion of the sides. The middle portion of the watercourses (Phase 2) is cut in tufa, which is not capable of absorbing as much water as the bed of Phase 1. Also its streams are augmented by the water which is handed on from the catchment area of Phase 1. It therefore follows that the volume of water in the streams of Phase 2, and therefore, *ceteris paribus*, their erosive power, must be far greater than in the streams of the upper portion of the valley. Again, inasmuch as the lower layers of tufa contain more water than the upper ones, and consequently have less absorptive power, the deeper the streams run below the surface of the ground, the less will their volume diminish by absorption. In confirmation of this, I have observed on several occasions that during a sharp shower streams begin to form and run in the lower parts of the cavoni before they form in the upper, and long before they form in the first section of Phase 1. During a shower the process of stream-formation seems to begin low down in the valley beds, and to travel up.

In the lower section (Phase 3), where the inclination of the bed is small, and

the slower-moving streams can no longer hold much matter in suspension, sandy deposits are formed, which sometimes cause the stream to branch, as is also the case with the Lagni of Monte Somma.

References (see also p. 435).

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Tenore, M.—Essai sur la Géographie physique et botanique du royaume de Naples. Naples, 1827.

Explanation of Maps and Diagrams.

Map I.—Contoured map of the Campi Phlegræi, west of Naples.

Contours at intervals of 10 metres. The stronger lines are 50 metres apart. Scale 1 : 50,000.

The crests of those hills which are described as parts of volcanic crater-rings in the paper are indicated by red lines.

\+ Lava-flows or trachytic lava masses.

° Mineral springs.

˅ Fumaroles and moffette.

The map is for the most part based upon the 1 : 25,000 map published in 1885 by the Istituto Geografico Militare, to which the reader is referred for further details. The sea-bed has been compiled from the soundings given on Admiralty Charts, Nos. 1400 and 1728. The Secca di Benda Palumma is after Colombo's map from Walther (16, p. 435).

Map II.—Avernus group of craters. M. Nuovo, Avernus, M. Grillo-Rosso, Cuma.

Map III.—Lake Avernus.

Soundings in metres. Contour-lines 10 metres apart. The surface of the lake is 1·08 metre above sea-level.

Sections: horizontal scale 1 : 11,000; vertical scale 1 : 72,000.

Map IV.—Archiagnano group of craters. Cf. Map I.

Map V.—The valley systems of Camaldoli.

Valley beds blue. Watersheds and contours brown. The watersheds represented by stronger lines are those separating the valley systems enumerated on p. 479. The watersheds are continued down to the contour-lines specified in the tables, p. 486.

Scale 1 : 50,000.

Map VI.—Map of the Camaldoli hills restored, with the valleys filled in.

This map is supposed to more nearly represent the condition of things before denudation had commenced. Compare with the corresponding portion of Map I.

Map VII.—Longitudinal sectional elevations of Camaldoli valleys.

In each diagram the lower line represents the valley bed, the upper line the mean height of the banks. The space enclosed is the "erosion area" (see p. 486).

Horizontal scale 1 : 50,000; vertical scale 1 : 20,000.

Map VIII.—Vertical sections through Camaldoli.

1. Section from Piano di Quarto to the Riviera di Chiaja.

2. Section from Piano di Pianura to Capodimonte Park.

Horizontal scale 1 : 20,000; vertical scale 1 : 50,000.

BRITISH CAVES AND SPELEOLOGY.

By E. A. MARTEL.

At the last meeting of the Sixth International Geographical Congress held in London, in July and August, 1895, I had the honour, as delegate of the Society of Speleology, of communicating a memorandum on the encouragement which ought to be given to researches of all kinds in caves. I explained how the new means of action employed since 1883, above all in Austria by different scientists and travellers, and in France by myself and my fellow-labourers, had resulted in unexpected discoveries. The principal aim of my communication was to attract the attention of English scientific men and tourists to all that still remains to be done and to be found in the natural caves of Great Britain. Alluding to the two works that I had already published,* I tried to prove how speleology, or the science of caves, if it received the attention which it deserves, will help to solve a great number of problems, not only in physical geography, but also in palæontology, zoology, meteorology, agriculture, public works, general hygiene, etc. In order to join example to precept, I had obtained from the French Government, as I did in 1893 for the Austrian Karst, a scientific mission in the name of the Minister of Public Instruction to make a comparison between the grottoes and subterranean waters of Great Britain and those which I had already examined in France, Belgium, Austria, and Greece.

The results of this mission, very fortunately accomplished in July and August, 1895, were abundant enough to furnish matter for a special new work, which was issued in January 1897†; but, wishing to make known to the readers of the *Geographical Journal* at least the principal observations and discoveries which I have made in Ireland, Derbyshire, and Yorkshire, I will devote these few pages to a summary relation of my underground journey in the British Isles, adding afterwards a few words on my researches of 1896 in Spain. I hope thus to succeed in arousing in England a favourable extension of all kinds of subterranean researches, as I have already had the pleasure of succeeding in doing in France.

I.—General Remarks on British Caves.

At the beginning of the present century, the caves of England were the object of learned and methodical researches. In 1821 Dr. Buckland undertook the famous excavations of Kirkdale cave, described in his classical work 'Reliquiæ Diluvianæ.'‡ One knows what splendid palæontological discoveries have been furnished by the beds of Hutton, Oreston, Wookey, Victoria, Brixham caves, of Kent's hole, Dream mine, Goat hole (Paviland), etc. The summary of all this has been described by Prof. Boyd Dawkins in his excellent work 'Cave Hunting,' published in 1874.§ The mere reading of this valuable volume will suffice to show that palæontology and archæology have been until now the principal objects of English speleologists. One may say that in general they have not thoroughly examined all that concerns the topography, the hydrology, the meteorology, and

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* 'Les Cévennes.' In 8vo. Paris: Delagrave. 1890. 'Les Abîmes.' In 4to. Paris: Delagrave. 1894.

† 'Irlande et Cavernes anglaises.' In 8vo. Paris: Delagrave. 1897.

‡ In 4to. London: Murray. 1823.

§ 'Cave Hunting: Researches on the Evidence of Caves, respecting the Early Inhabitants of Europe.' In 8vo; xxiv., 455 pp.; one plate in colours and fig. London: MacMillan. 1874.

the zoology of their underground caves. On this last point they are very much behind their scientific brethren of Austria, America, and France, as, up to 1895, there was only one grotto in the British Isles—that of Mitchelstown, in Ireland—in which specimens of the fauna special to caverns had been met with. We cannot doubt that this is for want of sufficient researches. The opinion held by Prof. Boyd Dawkins in 1874, that the temperature of caves is in general (like that of springs) invariable, and equal "to the annual mean temperature of the place," was only really recognized as inexact since my own researches. I proved that it was also without foundation in England.* It is all the more singular to see the British caves thus incompletely studied, as every circumstance seems to favour a careful investigation; in effect, great stretches of tableland and hills are perforated with fissures into which the rainwater is engulfed, with caves which receive them, and sources which distribute them. These regions are very easy of access; they are neither lost in the heart of high mountains, nor far from roads and great centres, as those into which the swallow-holes of the French *causses* open. The 1: 10,560 county map, or 6-inch map, facilitates in a very great measure, and better than in any other country, the knowledge of the land. And the nation which has created the dangerous sport of alpine climbing and founded the first alpine club is far from wanting in initiative and fearlessness. Also we can hardly understand why the courageous Messrs. Lloyd, Birkbeck, and Metcalfe, who, as far back as 1770 and 1847, did not fear to descend into Eldon hole and Allum pot—two abysses of 300 feet deep (of which 180 are perpendicular), have not had more imitators.

In short, the underground of the calcareous regions of the British Isles may be considered as being, topographically, very little known; this is the conviction which was impressed on my mind by my own researches in 1895.

II.—Marble Arch (Ireland).

Dr. Scharff, of the Irish Museum of Science and Art at Dublin, procured me the co-operation of Mr. Jameson for the exploration of some of the Irish grottoes. His help has been most valuable to me in exploring the caves near Enniskillen (Fermanagh). Marble Arch, which is certainly the most important of all these cavities, is situated 10 miles (as the crow flies) south-west of Enniskillen, at the entrance to the park of the Earl of Enniskillen. The Cladagh (219 feet), a foaming torrent rushing out of a charming woody ravine, narrow and walled in between abrupt slopes for a height of 150 to 250 feet. After a mile's walk up the ravine, we come to a natural arcade of stone, a calcareous layer which has remained stationary, and under which the entire torrent leaps, raging through the stones with which the bed is strewn. The map (sheet 56, Swanlinbar) indicates, at half a mile, two-thirds of a mile, and a mile, south and south-east of Marble Arch, three rivers (Sruh Croppa, Monastir or Owenbrean; the third has no name), which here, running under the rocks, drain the northern turfy slopes of Cuilcagh (2188 feet), and disappear suddenly into three holes, Cat's hole, Pollawaddy, Pollasumera.

On July 16, 1895, I undertook, with Mr. Jameson, to find out the quite unknown underground relations between the three rivers and the source. It is difficult to imagine a subterranean arrangement more complicated than at Marble Arch. Three storeys are here superposed: (1) the channels of the subterranean

* *Comptes Rendus* of the Academy of Sciences, Paris, March 12, 1894; January 13, 1896; May 24 and June 14, 1897.

river; (2) three galleries, perforated at about 16 feet above the water which circulated there formerly, and which perhaps passes there still when there are inundations; (3) four openings caused by the falling in of the tableland between 30 and 80 feet higher up. But it is impossible to meet with a more striking example of the destructive powers of subterranean waters. Erosion, corrosion, and hydrostatic pressure have, by widening the natural fissures of the ground, formed a real sponge of stone, about 500 feet long by 200 feet wide. Under the continual action of the internal current, the rock has become, in some way, more and more carious, like a bad tooth. At the points the most attacked, the hollowing out has reached such a development that the overweighing mass fell in, thus producing the four funnels. In short, the formation by the falling in of ground, due to the sapping of a subterranean river, is nowhere, not even at St. Canzian-in-Wald, near Adelsberg,* more evident and more eloquent than here; and the partisans of the theory which attributes the origin of natural wells principally to this cause, will find at Marble Arch one of the best arguments in favour of their thesis. They ought to note, nevertheless, that the want of thickness in the tableland over the cavern (45 to 125 feet at most) is a circumstance particularly favourable to this giving way of the earth, and that, conformably to the distinction that I established already in 1889,† and that is here confirmed, the conditions are no longer the same when the thickness is more than 300 feet. In this case, the narrow vertical abysses from 300 to 1000 feet deep, due, above all, to the external action of the streams which are, or were, engulfed into them (Karst, Causses, Vaucluse, etc.), are much more frequently met with than the gulfs really formed by the giving way of land; the latter are then only exceptions, of which the Dolinas of Recca at St. Canzian am Karst (Istria),‡ Padirac (Lot),§ and perhaps Mazocha, in Moravia, are without doubt the finest examples.

Behind the boulders, the subterranean stream occupies the entire section of a huge gallery. To the extent of 1000 feet we followed, in my folding boat, a great tunnel, previously unknown to man, elbowed in two places with sharp angles. The height and width of this tunnel vary from 25 to 45 feet; it is as imposing as the finest sections of the subterranean Piuka of Adelsberg (see engraving, "Underground river at Marble Arch, Ireland"). At the second elbow there is a cross-way, from whence a dry gallery is prolonged towards the north-east, the principal gallery coming from the south-west. At 650 feet from the cross-way we are stopped by the rocks approaching within 10 inches of the level of the water and not allowing our boat to pass. There are 15 feet difference of level between the source of Marble Arch and the water-surface of the large gallery, where the river has a temperature of 53° Fahr.

In short, it seems that the underground river here has utilized and enlarged the natural fissures of the rocks and formed them into magnificent galleries. Such is probably the origin of the curious labyrinth of the caves of Marble Arch, of which the total development attains nearly half a mile in length.

At a quarter of a mile as the crow flies, south-south-west of Marble Arch, there is another external giving way of the earth. The 6-inch map names it Cradle hole. Five or six times more vast than any of the other four funnels of Marble Arch, it was, like them, produced by the falling in of a subterranean vault. In the north-east inferior angle there is a cave, less complex and

* See 'Les Abîmes,' p. 459.

† *Comptes Rendus Acad. des Sciences*, October 14, 1889.

‡ 'Les Abîmes,' p. 459.

§ Ibid., p. 263; and 'Tour du Monde,' December, 1890.

less extended than those of Marble Arch, and of which every hole and corner was known for a long while. The whole ends in a wide gallery 300 feet long,

UNDERGROUND RIVER AT MARBLE ARCH, IRELAND.
(*Lent by the French Alpine Club.*)

similar in form, cut, and dimensions to the one we discovered at Marble Arch. There is also a river in it. The barometer marks 450 feet of altitude—that is to say, 15 feet more than at the end of the large gallery of 650 feet in Marble Arch.

A communication in form of a siphon exists between the two currents. The ramifications of the cave of Cradle hole have about from 800 to 1000 feet of development.

At 220 yards from Cradle hole there is a yawning chasm, the sides of which have been but lately disclosed; it is, without doubt, quite a recent giving way of the ground (altitude 600 feet), which is not marked on the county map. It is smaller than Cradle hole, and no cave opens at the bottom; it has unhappily obliterated the subterranean passage, over which the sinking of the earth has taken place. Barely a quarter of a mile farther on, or at about one-third of a mile from Cradle hole, and about half a mile from Marble Arch, there is a real pit (aven), that is to say, a narrow natural well (altitude 620 feet). The fathom-line descends 72 feet, that is to say, to the altitude of 550 feet, or about that. Unhappily, we had not time to descend into it, as we wished to examine, at 50 yards from there, the spot where the river Monastir (or Owenbrean) loses itself under the rocks at Pollawaddy. This river descends from the very summit of Cuilcagh. Its disappearance is very picturesque. At 612 feet of altitude (map) the ground comes suddenly to an abrupt termination, and a cliff from 60 to 80 feet high forms a precipice at our feet, barring a hollow ravine at least 320 feet wide, into which the river descends in small cascades. A little byway leads us to its banks, at the very foot of the cliff, into which the water (58° Fahr.) disappears. In the very course of the stream, which is 20 inches deep, we enter under a gallery, 3 feet wide and from 10 to 25 feet high. At 130 feet from the entrance we were stopped by a large stem of a tree, which we could not remove. Thus we were compelled not to know if the stream would have led us to the foot of the pit.

It now remains to descend into the pit (aven), and to finish the exploration of the disappearance of the river at Pollawaddy, as well as of Cat's hole (quarter of a mile north-west of Pollawaddy), where the stream Sruh Croppah disappears; and of Pollasumera (two-thirds of a mile east from Pollawaddy), where a third nameless river is also swallowed.

III.—Arch Cave or Waterfall Cave, Ireland.

Opposite to Cuilcagh, the mountains of Belmore (1312 feet) include also between lakes Macnean, Melvin, and upper Erne, some calcareous ground, the subterranean hydrology of which deserves to be studied. On July 14 and 15, 1895, with the very obliging indications of Mr. Plunkett, of Enniskillen, who had himself made some pre-historic excavations in different little caves of Belmore, Mr. Jameson and I examined the basin that serves to feed the source of Arch cave, or Waterfall cave, situated at about 8 miles west of Enniskillen. It is one of the most curious springs that I have ever observed, and was opened by the force of underground waters between the clefts and joints of carboniferous limestone. The origin of the powerful source of Arch cave, whose volume announces the drainage of a rather considerable surface of ground, must be as follows:—

This surface is that of a tableland with three shelves or terraces, which extends towards the west of the cave, and constitutes, in a gentle slope, the eastern declivity of the hills of Tullybrack (1223–1249 feet).

On this tableland a quantity of swallow-holes are the points of absorption of the atmospheric waters. The greatest part of these swallow-holes, or pipes, are impenetrable, being full of pebbles and lumps of earth, like the *betoires* of France, and the *Sauglöcher* of Austria; but at least two are open and penetrable, like the abysses, or pits, and we descended into them. The first, Sumera, or Noon's hole, is the deeper and the more curious; the plumb-line marked 154 feet, that is, 216 feet above the outlet of Arch cave, as the hole opens at 747 feet of altitude. It is a real

swallow-hole, but it is not finished; the stream that has already widened it continues its work of enlarging—it still falls into it, and so strongly that we were obliged to limit our descent to 60 feet. At the depth of 80 feet the cavity gets narrower; it has then only 3 feet diameter instead of from 16 to 25, as at the orifice, and the waterfall occupies all the section.

To examine the bottom of it, and to seek the prolongation of Noon's hole, it would be necessary to re-descend into it in a drier season. At least, I have had the satisfaction of verifying that most of those long and narrow vertical abysses of the Causses and of the Karst, which are to-day so dry, are in reality the work of superficial waters formerly absorbed there and now dried up; that they have been formed from top to bottom at the expense of the fissures of the ground, which have been enlarged by erosion and corrosion; and that the opposition that I made, in insisting on this new theory, to the excessive generalization of the hypothesis of the sinking vaults is absolutely justified. Ingleborough hill, in Yorkshire, will furnish us with still more magnificent examples of abysses having kept, until now, their character of absorbing wells.

The other penetrable swallow-hole is Pollanafrin, at half a mile south of Noon's hole, and at 690 feet altitude, only 32 feet deep on one side, and 46 feet on the other. This hole is really the production of a sinking-in of ground; the stream which crosses it has disappeared, a few yards upwards, on the third terrace, into small crevices of its bed. It is sure that all these waters reappear at Arch cave, which is half a mile distant.

IV.—Other Researches in Ireland.

My other underground explorations in Ireland were only interesting from a geological point of view, and were fully reported in my last book. At Cong I found the celebrated Pigeon's hole was not worth its reputation, and I could not discover the subterranean river between Lough Mask and Lough Corrib, though descending in a few not very deep, reputed unfathomable, abysses. The underground rivers of Galway and Clare (at Gort, the Tomeens near Tulla, etc.) did not prove so magnificent as Marble Arch and Arch cave. Theoretically, however, I gathered there much useful information, especially in the existence of really unfinished valleys, where subterranean rivers have not yet wholly destroyed their cavernous prisons. I think I must notice that, quite near the little town of Gort, at 1½ mile east of Kiltartan, a phenomenon is to be seen which is perhaps unique in the physical geography of the Earth; at least, I have never seen its equivalent. In its downward course from the hamlet and the mill of Ballylee (a ruined castle), the river, which bears the six successive names of Boleyneendorish, Ballycahalan, Annagh, Turra, Streamstown, and Ballylee, forks suddenly in two arms; opposite each other, at an angle of 180°, these two arms run towards the two opposite extremities of the valley, and sink both—that of the north-east (Pollaleen, altitude 40 feet) after 800 feet of course, that of the south-west (Pollanoween, double, altitude 32 feet) after 1550 feet. The two holes into which these rivers disappear are impenetrable, as are all those of Gort. But the maps do not indicate at all this double current going in contrary directions; I have not seen it mentioned in any work, and I was quite surprised to discover, on the spot itself, this unusual division of waters, nearly on the threshold of two subterranean disappearances, which go no one knows where.

Here I find opportunity to say a word about the *turloughs* (or blind loughs) and the *sluggas* or *sluggys*.

The *sluggas* are simply the light-holes of a sinking in of the ground. These holes must not be mistaken for swallow-holes, like those into which the river

Beagh disappears near Gort, nor for real abysses (pot-holes or pipes) like Noon's hole (see above).

THE INTERIOR OF GAPING GHYLL, IN YORKSHIRE.
(*Lent by the French Alpine Club.*)

The *turloughs*, or lakes with changeable water-level, alternatively fill and empty themselves by the bottom, according to the oscillations of the swelling or

the decrease of the waters; they are simply the overflowing of the subterranean channels which drain the calcareous ground through its fissures. They repeat here exactly what takes place in the famous lake of Zirknitz, in Carniole (see 'Les Abîmes,' p. 458), of which the irregular ebbing and flowing were so long unexplained.

The chief causes of the multiplicity of these lakes, and the frequency of the phenomena in Ireland, are the slight altitude of the ground and the feeble slope of the subterranean waters which ensues. If the island rose only 300 feet, the drainage would be considerably accelerated, and by degrees would be formed, thanks to the recrudescence of the erosion, more important caverns and more uninterrupted valleys. The flatness of the country has not permitted the trickling down and the infiltration of the waters to do their work as deeply and as completely as, for instance, in the regions of the Causses, the Jura, and the Karst. That is why there are in Ireland so many lakes without any apparent overflow channel, and of which the subterranean issues are unknown, going out, probably, into the sea; this is certain, at least, for some of them which are rather near the coasts, and on the level of which the tide has a visible influence (see Kinahan, 'Valleys, Fissures,' etc., p. 151; 'Les Abîmes,' p. 530).

I have found that the famous Mitchelstown cave (county Tipperary), though one of the largest of great Britain (1¼ mile extent), is certainly much inferior in beauty to the best Austrian and French caves, such as Adelsberg and Dargilan.

To conclude, for Ireland, very much speleological work of all kind remains to be done in the "Green Isle."

V.—The Caves of the Peak District, Derbyshire.

Peak cavern, just behind the village of Castleton (Derbyshire), is perhaps the most popular in England, and numerous tourists visit it daily. The entrance part alone is worthy of admiration. It is a subterranean river which has made this monumental porch; but it no longer utilizes it, except for the surplus waters in moments of inundation, for its former strength has much decreased, and it bursts out to-day at three points, towards the descent of the river and on an inferior level. The interior of Peak cavern does not possess one single fine concretion. But behind the larger rooms, which are occupied by water only after floods, the subterranean river can be followed side by side in a gallery of 1000 feet; the stream runs noisily along between clay banks. In the vault are transverse diaclases widening out into spindles, as in Marble Arch, Arch cave, etc.; three of them are large fissures of infiltration. The last of these vertical crevices is an enormous abyss (swallow-hole), one of those upward fissures that the miners of the country call "rakes;" it is from 18 to 30 feet wide, and inclines from 75° to 80° towards the horizon. It is an unfinished abyss; that is to say, it is a crack that erosion has not enlarged up to the surface of the earth, for its orifice has not been found above. It is very elevated, although it has not, probably, the 300 feet in height that is attributed to it; if it had, it would pierce the surface of the earth, which, according to the superposition of the 6-inch map and of my own subterranean mapping, must be in this spot about 100 yards above the level of the interior river. This gulf closed above, called Victoria cave, discovered in 1842, enters into the category of swallow-holes grafted laterally on subterranean rivers, such as Rabanel, the Combettes, the Mas Raynal,* and the larger dome of Padirac,† in France.

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* See 'Les Abîmes,' pp. 143, 172, 325.

† See *Comptes Rendus Acad. des Sci.*, October 21, 1895, and *La Nature*, October 16, 1895.

As with all the vertical clefts in the vaults of caverns, it would be well to ascend the interior of this one, in order to find out if it be not an issue to one or several storeys of other grottoes.

Just at the foot of Victoria cave, a small streamlet comes out of a very short gallery (see plan); its course is stopped above, after a few yards, by a pond of water. The temperature of this affluent I found to be 46·5° Fahr. It is very probable that it comes from the second grotto of Castleton, the so-called Speedwell mine. Afterwards the gallery of the principal stream in Peak cavern turns abruptly at right angle towards the south-east; at the end of 90 feet the path is cut off by water 3 feet deep. Wading through it 20 yards, I ascertained that the stream came from under a siphon, and that there is no prolongation, *free for man*, towards the Perryfoot swallow-hole. But it is, nevertheless, quite certain that all the swallow-holes in the great fault of Derbyshire, in the tableland north-west from Castleton, duly run their waters through these caves.

The Speedwell and Blue John mines are particularly curious for their relations with lead ore; but on this specially geological subject I have given a fuller account in my book. Here I will only say that they led to huge interior abysses, similar to Victoria cave in Peak cavern, and draining also the infiltration waters.

Another famous grotto in the district, Bagshaw cave, at Bradwell, was discovered accidentally in 1806 by four miners, who were searching for lead. In it there exists no great hall, and the width and height nowhere exceed 18 feet. The passage through it is difficult; but it must be admitted that, from a hydrological point of view, the cave of Bagshaw is also most interesting. It is composed of three parallel galleries, hollowed out on three different levels, but not on the same vertical plan, and, nevertheless, communicating with each other. The third is at this very time traversed by a subterranean river, and does not appear to be accessible to man. The middle gallery, or principal one, is the characteristic bed of an ancient subterranean river, now dried up. There it is necessary to drag one's self along flat on the ground, and to cross over a pond of water to reach a bifurcation, from whence can be heard the roaring of a torrent, which is very painfully reached. The subterranean river (altitude 606 feet) comes out of a vault nearly on a level with the water; it runs from south to north for the length of 15 or 18 feet, occupying all the width of the gallery, and is then engulfed, after rushing through the stones under another vault 2¼ feet high and 3 feet wide. A boat could not pass there on account of the stones, and the strength of the current prevented my risking to go on foot. The direction is that of Bradwell, towards the north-east. There is no notice of the waterfall in guide-books. Unless the river were dried up, I consider it impossible to go farther than I have been myself. The extent of the cave of Bagshaw must, then, be limited to the half-mile that I went over myself, and to the gallery of the Dungeon; that is to say, from three-quarters to one mile in all. Such as it is, Bagshaw cave is one of the longest in England. In a straight line, the point where I met the subterranean river is half a mile from the entrance, and half a mile * from a powerful and impenetrable spring, which rushes out in the village of Bradwell itself, between 580 and 590 feet of altitude, and from 15 to 30 feet lower than the ground of the cave. It is really the torrent of Bagshaw cave that feeds the source of Bradwell, and if ever the latter dries up, they will know where to go to look for it. As for its origin, I

* It is only in adding to the accessible length the unknown and impracticable passages, and even in supposing windings that would double its length, that we arrive at the number 2 miles, which until now has been considered as the extent of the cave of Bagshaw (Baddeley, 'Guide for the Peak District').

can conjecture nothing about it, except that it surely comes from the draining of the limestone tableland towards Tideswell.

VI.—Caves of Yorkshire. Gaping Ghyll.

Long ago, Prof. Phillips, Prof. Boyd-Dawkins, Messrs. Marr, Dakyns, Tiddemann, etc., have drawn attention to the caves and pot-holes of Ingleborough and surrounding mountains of Yorkshire. The two principal pot-holes of Ingleborough are Allum Pot and Gaping Ghyll; the last one engulfs the large stream of Fell Beck. Allum Pot, 300 feet deep (198 feet of which are perpendicular), was first visited in 1847 by Messrs. Birkbeck and Metcalfe, afterwards by Prof. Boyd-Dawkins and other parties.* Of the second (altitude 1310 feet), nobody, until 1896, had been able to reach the bottom. Prof. Hughes had only measured it with a plumb-line in 1872, and had found a depth of 300 perpendicular feet. On August 1, 1895, thanks to the obliging help of Mr. Farrer, who had got Fell Beck partly turned aside, I was able to accomplish the first descent of Gaping Ghyll, and to find out that this hole is, above all, an abyss of erosion formed from top to bottom by the widening out of a diaclase. The vertical cascade of 300 feet, which falls into it in a single jet, and the volume of which is enormous after storms or the melting of the snow, proves that the natural chimneys of the same form must have had an identical origin, even when we find them dried up and much deeper, as those of Rabanel in the Hérault, and of Jean-Nouveau in Vaucluse.† Gaping Ghyll is a swallow-hole which has not ceased to work as a perennial swallow-hole.

At a depth of 210 feet, its large pipe, from 13 to 29 feet in diameter, opens in the vault of an immense subterranean hall, 480 feet long, from 70 to 110 feet wide, and from 80 to 100 feet high. The ground (altitude, 300 metres), formed of gravel and round pebbles, is remarkably flat. The surface is about 4500 square yards. It is the work of the waters, which, stopped in their descent by the impermeable sub-stratum of the silurian slates, have, by widening the joints of stratification and the diaclases, excavated this great reservoir of more than 100,000 cubic yards of capacity. At its two extremities, I found the cave obstructed by such heaps of stone that I was not able, having gone down quite alone, to remove them. But in 1896 the large party of MM. Calvert, Gray, Booth, Green, Cuttriss, Slingsby, etc., made several descents in Gaping Ghyll, and succeeded in discovering more than half a mile of galleries behind the heaps of stones. Their researches are not finished, and will be continued. But it is now ascertained that the stream comes out 140 feet lower down, and about three-quarters of a mile farther on (as the crow flies), through the grotto of Ingleborough (altitude 825 feet). Since 1839 they have penetrated for 2000 feet into the turning gallery which this grotto forms, and they have been stopped by the lowering of the vaulting to the level of the water. In 1896 Messrs. Calvert, Gray, etc., found a new gallery in Ingleborough cave, and now but a little part of the subterranean river remains unknown.‡

I was also much interested, in the north-west of Ingleton, with the stream of Doe or Dale Beck, whose capricious course I carefully studied, marking many new observations, especially on the famous Weathercote cave, which I have accurately mapped and explained in my book (chap. xxv.).

Lots of caves, abysses, and swallow-holes are still to be scientifically explored round Ingleborough, as well as in Ireland, Derbyshire, and Mendip hills. Many

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* See Boyd-Dawkins, 'Cave Hunting,' in 8vo, p. 41. London. 1874.

† See *Comptes Rendus de l'Académie des Sciences*, October 14, 1889; and 'Les Abîmes.'

‡ For a more detailed account of my descent in Gaping Ghyll, see *Alpine Journal*, May, 1896, and chaps. xxiii. and xxiv. of 'Irlande et caverns anglaises.'

months, or even years, and many men must be employed for this work. I could only, almost alone and with limited time, disclose very few of the remaining mysteries of British caves, but I trust that my too short investigations, specially those in Marble Arch and Gaping Ghyll, have succeeded in proving that speleology is quite likely to effect future discoveries in Great Britain, just as it has done in Austria and France during ten years.

This was my principal aim in the above very rapidly described journey, and I wish that cave-hunting may be now energetically resumed there by English investigators, to the great benefit of human knowledge and curiosity.

VII.—The Cueva del Drach, in Majorca (Spain).

In 1896 I turned my attention to another part of Europe, the Spanish Majorca, in the Balearic islands, where a natural marvel was said to be incompletely known

LAGO MIRAMAR, MAJORCA.

—I mean the Cueva del Drach, that is, the Dragon's cave, on the eastern shore of the island, about 8 miles east from the town of Manacor. Since the year 1878 only this cave had been visited, after two gentlemen of Barcelona, with an inefficient guide, had tried to thoroughly explore the cueva—had, in fact, discovered some new rooms, but succeeded principally in losing themselves during a whole day, and in getting half dead from hunger and fright. Actually about half a mile of galleries were known in this cave, adorned with the most beautiful stalactites and stalagmites, and with wonderful little lakes, which had stopped any further investigation (see Vuillier, 'Les iles oubliées').

Several years ago I was invited by His Imperial Highness, the Archduke Louis Salvator of Austria, the learned and generous owner of the Miramar estates near Palma, to work out the exploration of Dragon's cave. It was only in September, 1896, that I at length was able to carry this scheme into execution. But, thanks

to the facilities granted by his Highness and with my folding canvas boats, I was pleased and happy in carrying out at Cueva del Drach one of my most satisfactory subterranean investigations.

I found one of the largest underground lakes known in the world, which I named Lago Miramar, 570 feet long, 100 to 125 feet wide, 15 to 30 feet deep. The accompanying photographic illustration (taken with magnesium light in ten minutes) represents a corner of this lake, and shows better than any long description what a marvel is this mysterious and so long unknown pond, black as night, but sparkling under magnesium wire with all the splendours of the diamond. The vaults and walls are covered with millions of sharp and thin stalactite needles; the roof is supported at intervals by stalagmitic columns resembling the Egyptian or Indian pillars of Karnac or Kailaça. All these concretions are pure white like ermine, without any spot of clay. It presents the greatest contrast to Gaping Ghyll, being a masterpiece of beauty, just as the Yorkshire abyss is of frightful magnitude, both stupefying to human eyes.

And Dragon's cave (1¼ mile long) is not only a picturesque curiosity; all its large and small lakes are on the same level as the sea, with which they communicate through narrow clefts; they are half salt and fresh water, and a hydrological marvel, of which I will give elsewhere a fuller scientific account.* For geographers I only say here that this cavern is a mere sea-cave formed by the Mediterranean waves, and not by an underground river, but a sea-cave of unusual size, unparalleled elsewhere, at least on European shores. It is said that California, Cuba, and Jamaica possess also grand caves of the same kind. When and by whom will they be scientifically explored?

ON THE DISTRIBUTION OF TOWNS AND VILLAGES IN ENGLAND.

By GEO. G. CHISHOLM, M.A., B.Sc.

II. Historical Aspects of the Question.†

In examining this subject from the historical point of view, we begin, of course, with the Roman towns. In pre-Roman times there were no towns. In the state of civilization reached by the Britons, there could be no use for them. So far as Cæsar had the opportunity of observing, there was little cultivation in Britain in his time

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* *Comptes Rendus de l'Académie des Sciences* 14 Juin 1897, *et Annuire du club alpine français*, 1896 (in press).

† Owing to a misunderstanding about the proof in the first of these papers (January, 1897), several misprints were left uncorrected, and should be corrected as follows:—

Page 79, line 3.	*For* Barstone *read* Carstone.
,, 80, ,, 3.	*For* deepened *read* cheapened.
,, 80, ,, 17.	*For* Buckmere *read* Cuckmere.
,, 80, ,, 25.	*For* Steywing *read* Steyning.
,, 81, note.	*For* Gonglis *read* Gough's.
,, 82, line 2.	*For* Whilton *read* Whitton.
,, 82, ,, 9.	*For* South *read* North.
,, 86, ,, 1.	*For* hillock *read* bullock.

except in Kent, the inhabitants living on milk and flesh, and wearing skins for clothing. The name of "town" they gave, he says, to an inaccessible wood fortified by a ditch and rampart, where they resorted to avoid invaders.

The geographical interest attaching to the Roman towns of Britain is all the greater because these towns appear to have been mostly abandoned after the Teutonic invasions of the fifth century. The organization of the Angles and Saxons hardly allowed a place for the existence of towns. Towns are mostly brought into existence as centres of trade, seats of manufacture, or places of administration; but the remarkably self-contained village life of the Angles and Saxons enabled them for centuries to dispense both with manufacturing and trading towns. Even the administration of the villages was independent, and the only administrative centre required was a capital whence, as occasion demanded, the king might summon his immediate followers to attend him with their retainers. Hence the Roman towns, where not still left in the hands of the Britons, were forsaken. The shell, or skeleton, of the town continued to exist in many cases till life was revived, if it was ever revived at all. Town life in England, according to Cunningham, did not begin again till the advent of the Danes, and was due to their trading instincts.* An interesting mark of this breach of continuity in town life, in the case of those Roman towns which were revived and still exist, is found in the want of continuity of the town names. Very few old Roman towns, or towns on the sites of old Roman forts, in England are known by names directly descended, that is, derived by mere linguistic corruption, from those which they had in the Latin tongue.†

Now, much of the geographical interest attaching to the history of Roman towns arises from the hints we get therefrom as to the geographical conditions that may have favoured their existence in the situations where they are found or formerly existed. Where Roman towns have continued to exist, or have been restored on the site originally occupied or on a site closely adjoining, there is at least a presumption that their existence on these sites is due to geographical conditions of an enduring kind. Where Roman towns have passed away and left no modern representative, the inference is that, if their existence could ever be fairly ascribed to geographical conditions, these conditions have changed.

Among Roman towns or stations that have continued to exist or have been revived, it is natural to find a considerable number of seaports, including river-ports accessible to sea-going ships. Among these may be mentioned Londinium (London), Durobrivæ (Rochester), Dubræ (Dover), Clausentum (Southampton), Isca (Exeter), Glevum (Gloucester), Segontium (Carnarvon), Deva (Chester), Pons

* 'Growth of English Industry and Commerce: Early and Middle Ages,' pp. 88, 89.

† How different from what we find in the names of ancient Gaul compared with those of modern France! There most of the ancient Roman names have come down in some form to the present day, and the towns themselves that were important in Roman times are more or less important still, and stand on the same sites. It is interesting, too, to note that the names that have thus persisted are often tribal names, and not the official names that may have been given to the towns by the administration, but which were in many cases displaced by tribal names even in Roman times. The names are often greatly corrupted; still such changes as Lemovices, Limoges, Divio (nem), Dijon, are of the same nature as those which have changed *abbreviare* into *abréger*, and are quite different from those which have taken place in names like Manchester and Lincoln, where new names have been formed by the combination of one element of the old name with a designation which the Anglo-Saxon settlers had learnt from the previous inhabitants.

Ælii (Newcastle), Eburacum (York), Venta Icenorum (Norwich), and Camulodunum (Colchester). To these we may add Aquæ Sulis (Bath), which, though it has long ceased to be a seaport, in all probability served all the purposes of a port for this district in Roman times when no Bristol existed, and Luguvallium (Carlisle), which continued to be a seaport down to a comparatively recent date.

Of the towns mentioned, Clausentum and Venta Icenorum do not appear to have occupied the exact site of their modern representatives, and the difference in situation, slight as it is in both cases, is not without interest. The exact site of the Roman Clausentum is now occupied by the village of Bitterne, at the head, but on the east side, of the small estuary of the Itchen,* where Camden was shown ruins, walls, and ditches of an ancient castle about half a mile in circuit, and surrounded on three sides by the sea at flood tide, where, he adds, coins of Roman emperors were frequently dug up. Through the care of the late Sir Stuart Macnaghten, the old Roman boundaries of the station, which was an insular one, have been preserved, and can still be seen. The coins found here are chiefly of the later empire, those of Tetricus, one of "the thirty tyrants," being most numerous. A port at this spot would be the highest point that sea-going ships could reach on their way to Winchester, then the principal goal in this region. As traffic increased, the more extensive accommodation for loading and unloading on the peninsula between the Itchen and Test would give greater advantages to that site. Venta Icenorum appears to have occupied the site of the modern village of Caistor, which lies a little to the south of Norwich, on a small river called the Tese, probably navigable to this point in Roman times, and would be the first navigable point reached in following the road to the Yare from the south.

Besides Clausentum and Venta Icenorum, Portus Adurni (? Porchester), Tamara (near Tamerton, on the Plym), and Gariannonum (Burgh Castle, on the Yare), may also be mentioned as having their modern representatives as seaports at some little distance from the ancient towns. Whether Porchester is to be identified with Portus Adurni or not,† its name seems clearly to indicate the presence of some Roman port here. It is now represented by Portsmouth, the foundation of which is ascribed by Camden to the removal of the inhabitants from Porchester to the island of Portsea, in consequence of "the gradual withdrawing of the sea." At no period, however, can the harbour on which these ports stand have had anything like the commercial importance of Southampton, which is much better situated for communication with the interior, and does not suffer from the disadvantage of the strongly flowing and ebbing tides, which at times render the navigation of the entrance to the other port extremely difficult. The commodiousness of the harbour as

* The very plausible derivation given by Camden for the name Clausentum would seem to militate against this identification. Camden suggests that Clausentum means the harbour of the Entum, or Anton, *claudh* meaning in "British" a harbour formed by artificial banks of earth (Pugh's Welsh dictionary defines *Clawdd* as "a dike, ditch, or trench, a pit or quarry; an embankment or wall thrown up;" the primary meaning evidently being "something made by digging"). The *dh*, or Welsh *dd*, pronounced like the *th* in *this*, would readily enough become an *s* (*z*) in the mouths of those who could not pronounce that sound. But Anton is the name of the river on the west side of the small peninsula on which Southampton stands. The name may very well have been given also, however, to what we call Southampton Water, and hence the name "port of Anton" would be suitable for any port at the head of that inlet.

† "*Porchester* Fort, possibly Portus Adurni."—F. Haverfield, in the list of places contained in the map of Roman Britain in the 'Historical Atlas of Modern Europe' (Oxford: Clarendon Press, 1896). See also *Archæological Journal*, vol. xlvi. p. 68.

a naval station is the main cause of the importance of Portsmouth. Modern railway facilities were required to give it the commercial value which it now also possesses.

Tamara, now represented by Plymouth, owes its displacement as a seaport to the increased size of vessels. When smaller sea-going vessels were in use, it was, of course, important that they should penetrate as far inland as they could. The displacement of Gariannonum, now represented by Yarmouth, is, on the other hand, probably due to a change in the coast-line. In Roman times, the present site of Burgh Castle appears to have been at the mouth of the Yare. Yarmouth, which dates from Saxon times, stands on a spit of blown sand, which holds back recent alluvium of the Yare and Bure.

Among Roman seaports which have not survived, at least as such, may be mentioned Portus Lemanis (Lympne), already referred to (vol. ix. p. 85); Regulbium (Reculver) and Rutupiæ (Richborough), both of which have lost their importance through the alluvial deposits which have filled up the Wantsum and the mouth of the Stour; Anderida (Pevensey), which has also been cut off from the sea by alluvial deposits; Regnum (Chichester); Branodunum (Brancaster); and Vainona (Wainfleet). Whether Regnum is, strictly speaking, to be included among the Roman seaports of Britain is perhaps doubtful. No doubt part of its importance was due to the fact that boats of light draught can navigate Chichester harbour (the inlet to the east of Hayling island); but it does not follow that they could reach the site of the city itself, the geographical importance of which is partly determined by other circumstances (see vol. ix. pp. 76, 77). Camden notes that the city "would have arisen to great splendour had not the harbour been at too great distance and inconvenient," and he adds that the inhabitants were then about to dig a new canal. The Lavant, the small stream on which the city stands, is useless for navigation; and the canal, which now admits barges of 4 feet draught to the city, follows a different course.

Branodonum is only known as one of the forts of the Saxon shore, but it is probably to be regarded as an ancient seaport, for there is no other place that it could have served as a defence for, so that it must have been erected to defend a landing-place from the sea. It is now quite cut off from the sea by the marshy alluvium already mentioned (vol. ix. pp. 76, 77), as here lining the base of the chalk cliffs of Norfolk.

Wainfleet, on the Lincolnshire shore of the Wash, is identified by Dr. Stukeley with Vainona (or rather with the Navione of Ravenna, of which Vainona is a corrected reading); and Mr. Skertchley, making the same identification, believes that here in Roman times was the main mouth of the Witham.* Leland (1549) speaks of Wainfleet at that time as a pretty market town on a creek near to the sea, with small vessels belonging to it; and this creek, he says, after entering a considerable way inland, sent out branches on either side into the fens.

Of Roman towns that stood on navigable rivers, the following may be mentioned as still retaining some of their ancient importance: Durovernum (Canterbury), Cæsaromagus (Chelmsford), Camboritum (Cambridge, or rather Grantchester, the predecessor of Cambridge), Durolipons (Godmanchester, opposite Huntingdon), Ratæ (Leicester), Lindum (Lincoln), Danum (Doncaster), Legeolium (Castleford), Calcaria (Tadcaster). Most of these were probably either at the head of navigation on the rivers on which they stand, or at fords, or both. The Stour was navigable to Canterbury down to comparatively recent times. The name of Cambridge, and that of its ancient representative, show that the bridge across the

* "Geology of the Fenland." By S. B. J. Skertchley ('Memoirs of the Geol. Survey of Great Britain and Ireland, 1877'), p. 15.

river here was preceded by a ford, *ritum*—being the Latinized form of the Welsh *rhyd*, "a ford." The name Castleford points to a similar origin for the town and its ancient predecessor. Leicester was long at the head of navigation of the Soar, the navigation being now continued beyond the town by canal. Tadcaster is still the head of navigation on the Wharfe. The importance of Lincoln as, on account of its position at a well-marked break in the Lincolnshire limestone, a point of convergence of roads, has often been remarked on. In Roman times, and for many hundreds of years afterwards, it was perhaps quite as important as a meeting-place of waterways. The Witham below Lincoln is still a waterway to the Wash for boats of 5 feet draught, and this line is continued west of Lincoln to the Trent at Torksey by the Foss dyke. The latter navigation at least was much more important formerly than now. According to Dr. Stukeley, Torksey occupies the site of a walled Roman town, and the castle existing in his day was founded, he says, on the old Roman granary, "which was much like Colchester castle, with circular towers at the corners." Southwards, Lincoln communicated with the Welland by the Car-dyke (that is, fen-dyke), the Roman navigable trench by which the waters from the higher grounds on the west were intercepted and thus prevented from drowning the low fenlands to the east. It began on the Welland to the west of Ermine Street, and, passing to the east side of that highway at Catesbridge, continued northwards by a nearly parallel course till it ultimately joined the Witham. The ditch still survives, though no longer navigable. In Roman times, and probably for long after, it must have added considerably to the importance both of Lincoln and Torksey. In Domesday Torksey is mentioned as a place with "two hundred burgesses enjoying not a few privileges, upon condition they should conduct the king's ambassadors when they come this way in their boats down the Trent, and bring them as far as York."* In Norman times, Lincoln is described by William of Malmesbury as one of the most populous cities in England, and a mart for commodities brought both by land and water. By Edward III. it was made a staple for wool, leather, lead, etc.; but two centuries later Camden says it is incredible how it had declined by age, only eighteen churches then remaining of the fifty which it had held in Edward III.'s time. By that time the Foss-dyke had got choked up. Bishop Atwater (1514–21) had begun to cleanse it in the hope of bringing vessels to Lincoln, but died before achieving his purpose.†

Of Roman river-towns which, like Torksey, have decayed without recovery, four—Isurium (Aldborough), Durobrivæ (Castor), Margidunum (East Bridgford), and Uriconium‡ (Wroxeter)—are worthy of special notice. Next to York, Isurium, which stood on the Ure a short distance above its confluence with the Swale, was the most important city in the valley of the Ouse. It is close to the terminus of river-navigation at the present day, the navigation being now continued to Ripon by canal; but this in itself could not have accounted for the growth of a town at this point, as the Swale, or eastern headwater of the Ouse, continues to be navigable a good deal further north. Probably the adoption of the site was due to the fact that, in proceeding northwards on the right side of the river by the direct road from Tadcaster, this was the first point at which the river could be conveniently forded, the road then proceeding beyond this point, between the Ure and the Swale, to Cataractonium (Catterick Bridge), where the latter river was crossed. After its decay, Isurium never revived, and such importance as it may have possessed as a centre of trade seems to have passed over to

* Camden's 'Britannia,' Gough's edit., vol. ii. p. 227.

† Leland, vol. i. p. 32.

‡ Or Vriconium; also found as Viroconium.

Ripon, the town which grew up round the abbey founded by Archbishop Wilfrid of York, in the infancy of the English Church.

As the importance of Isurium has passed over to Ripon, so that of Durobrivæ ("the passage of the river" Nen) has passed over to the city of Peterborough, which owes its origin to a monastery built in the early part of the seventh century by Peada and Wolpher, sons of Penda, the first Christian king of Mercia, a little to the east of the old Roman town, the site of which is still commemorated in the names of two villages, Castor, on the north or Northamptonshire (once the Danish) side of the river, and Chesterton, on the south, Huntingdonshire, or Anglian side of the river. Similarly, the importance of Margidunum, whatever that may have been, has passed over to Nottingham. The site where Roman remains have been found identified with those of Margidunum is on the Trent a few miles north-east of Nottingham, and the place may have had a certain importance in connection with the Trent navigation, since it is the first point at which the Fosse Way, coming from the south-west, approaches the river; but there are no evidences of any important crossing-place here in Roman times as there was in later days near Nottingham. Probably the forests of western Notts (Sherwood, etc.) extended further east in Roman times, and hence the most convenient communication with the north was first north-east to Lincoln, and then north-west between the forests of the present Nottingham and the marshes of the lower Trent and Don by Torksey, Doncaster, and Castleford to Tadcaster and York.

The remaining Roman towns that it may be interesting to consider are best noticed in connection with the great Roman roads. The great north-west road is that which came to be known as Watling Street. If we take it as beginning at Dover or Richborough, it passed by Canterbury and Rochester to London, then by Sulloniacæ (Brockley Hill), Verulamium (St. Albans), thence to the south point of the modern county of Leicester, from which point it forms the whole of the south-west boundary of that county (the only county boundary composed of nearly mathematically straight lines in England). On leaving Leicestershire, it first continues in a north-westerly, then in a westerly, direction to the north of the ancient forests between the Avon and the Severn, passing Letocetum (Wall), Pennocrucium (Penkridge), and touching the Severn at Uriconium (Wroxeter). From that point it probably ran north to Chester.

Important as this road undoubtedly was for centuries, it is somewhat remarkable that there is no town on it of any importance north of the Thames except St. Albans and the terminal city on the Dee. St. Albans, though always notable in English history, is of small consequence compared with what it was in Roman times, when it was the rival of London in importance and dignity, though not, of course, in commerce. If Letocetum had any importance in Roman times, that importance has passed to Lichfield, which is situated 2 or 3 miles to the north-east. Uriconium was certainly an important Roman town. Its precise position seems to have been determined by the fact that the Severn is here fordable, which it is not lower down. After the destruction of this town by the Danes, it may be said to have been replaced by Shrewsbury, the town which arose a few miles higher up, on a red hill† nearly encircled by the Severn—a position accordingly peculiarly well adapted for defence.

This Roman road was crossed by another called the Fosse Way, running from south-west to north-east. It no doubt branched off from some point on the great

* Etocetum, hitherto the usual, is, it seems, an incorrect spelling. See the list already referred to in the 'Historical Atlas of Europe.'

† Lower Permian (Rothliegendes).

south-western road to Exeter, but only begins to be traced in the neighbourhood of Ilchester, whence it passed north-east to Aquæ Sulis (Bath), Corinium (Cirencester), and that point in the south-west boundary of Leicestershire where a slight change is made in the direction of that boundary (from north-west by north to north-west by west). At this point it crossed Watling Street, and beyond that road its north-easterly direction was continued by Leicester to Lincoln.

On the Fosse Way, the only Roman towns besides Lincoln which have retained any importance are Bath, Cirencester, and Leicester. Bath still derives importance from the hot springs, to which it owes its present, as it owed its Roman, name, and by which in ancient times it gained celebrity. Cirencester, though still a town with several thousand inhabitants, no longer has the relative importance which it must have had in Roman times, when it was the point of convergence of several important roads, the Fosse Way being here crossed by the road from Silchester to Gloucester. It was probably the fact of the Soar navigation ending here that determined the revival of Leicester on its ancient Roman site.

An important Roman town might have been expected to exist at the point on the Leicestershire boundary already mentioned as the crossing-place of Watling Street and the Fosse Way. At present there are only one or two small villages in the neighbourhood of this spot, which still bears the name of High Cross, "from a cross," says Camden, "that anciently stood there on a high ground, now succeeded by a higher post with its props;" but the people round about stated that "here was a most flourishing city named Cleycester, which had a senate of its own, and of which Cleybrook (Claybrooke), about a mile off, was part, and that on both sides of the road foundations of hewn stone lie under the furrows, and Roman coins are very often ploughed up." This city he identified with the Bennonæ, or Venonæ, of the Itinerary of Antonine, and the identification has been generally followed.

Dr. Guest contends that the southern portion of the Ermine Street, or great north road leading out of London, was not of Roman construction, basing his belief on the absence of Roman stations, villas, and burying-grounds on the part of the road between London and Huntingdon (or Godmanchester—Durolipons), and on the fact that of the three Antonine itinera leading to London, two first run down Watling Street to the Fosse Way, and thence from Venonæ north-west, and one runs first to Colchester, and then by Cambridge to Huntingdon. If Dr. Guest is correct, we may conclude that the alluvium of the Lee, and the forests on both sides of that river, presented obstacles in the way of road-making which it was not worth while to overcome under the conditions then obtaining. The route north-eastwards led to the most populous and richest part of the country by a succession of places where deposits of gravel and sand (Ilford, Romford, Ingatestone) and pebble-beds (Brentwood) afforded sites for towns and villages, and to some extent, no doubt, road-making material. The stations between Colchester and Cambridge on the iter leading that way to Lincoln are not identified. The next beyond Godmanchester is Durobrivæ, already mentioned as identified with Castor, near Peterborough; and the only other till Lincoln is reached is Causennæ, identified with great probability with Ancaster, now only a small village a few miles north-east of Grantham. On this route, also, accordingly the only places identified still of importance are those already mentioned as sea or river ports.

It is the same north of York. As far as Newcastle, not a single Roman station in the north has been identified with a place which is now of any importance. West of the Pennine chain, Carlisle, which has always had some importance as the centre of the New Red Sandstone (Triassic red Permian) basin of the Eden, seems to be the only place of importance now which was also important in Roman times until we come to the Dee. It is noteworthy that, at least in the time of the

Itineraries of Antonine, the main line of communication with the far north, whether towards the east or west end of the wall, was by the east of England. The fifth iter, which gives one route from London to Carlisle, passes from the basin of the Tees to that of the Eden by the route now followed by the North-Eastern Railway. Bowes, the village which gives name to the station at the head of the valley on the east side of the upland part of the railway, occupies the site of the Roman station of Lavatræ on this route. The Roman station of Verteræ, near the head of the valley on the west side of the Pennine chain, occupied the site of the modern village of Brough, a little to the east of the northern branch of the North-Eastern line on this side. From Brough the Roman road passed down the valley to Carlisle. There was one intermediate station, and it may be remarked that this station stood not exactly on the site of the modern Penrith, the point on which one descends directly in coming from Shap Fell, by the route by the London and North-Western Railway and the high-road from Lancashire, but at the place where the road from the north-east crosses the Eamont just before reaching Penrith, namely, at Brougham Castle, whose name probably preserves that of the Roman station Brocavum.

There are two itinera giving routes from the north to Manchester and thence southwards, and both of these branch off from the route just spoken of. One of these (Iter II.) takes us from Carlisle to York, and then proceeds south-west by Tadcaster, and crosses the Pennine chain a second time before reaching Manchester. One intermediate station, Cambodunum, is mentioned, and this is now generally identified with Slack, which is now not even a hamlet, but a mere site about 3½ miles west by north in a direct line from the London and North-Western station at Huddersfield. The other route (Iter X.) is a very obscure one, and was made all the more obscure by the inconsistencies and various readings of the texts that Camden, Horsley, Reynolds, and other English antiquaries, had to deal with. A very plausible interpretation of this route, based on the revised text of Parthey and Pinder, is given by Mr. W. Thompson Watkin in vol. xxviii. of the *Archæological Journal*. According to this interpretation, Iter X. crosses Shap Fell a little to the east of the north road from Kendal, and, after crossing the Eden valley, is continued by the Maiden Way referred to by Scott in 'Guy Mannering' (ch. xxiii.) in the direction of the wall; but this view seems to be only partially adopted by Mr. Haverfield in his map of Roman Britain. Like Mr. Watkin, Mr. Haverfield appears to identify, though doubtfully, Coccium (an unimportant station) with Wigan on his map, but he does not enter it in his list; and Bremetannacum and Galacum are identified by both with Ribchester and Overborough respectively, the former now a mere village, though probably a considerable seaport in Roman times; the latter a site 2 or 3 miles south of Kirkby Lonsdale, about the place where the Lune enters Lancashire, now represented not even by a hamlet. Beyond this point Mr. Haverfield looks upon the route of the iter as dubious, though some Roman road is marked by him as following the remainder of the route marked out by Mr. Watkin. But on this part of the route also there was no station now of any importance, unless we may regard the modern lead-mining town of Alston as representing an ancient Roman lead-mining centre under the guardianship of a station (a mile or two to the north) at Whitley Castle, which is identified by Mr. Watkin with Glanoventa, and has been identified by others with other stations. All interpretations of this iter agree in identifying Mancunium with Manchester, but there is no evidence that Manchester itself was a place of any importance in Roman times. The Roman remains found there are scanty, and its site in Roman times had no advantages. Marshes, forests, and sandy wastes seem to have then rendered south-west Lancashire of little value. The site seems to have been determined by the "hard rock of stone" which Leland speaks of on the banks of the Irwell, a good

foundation for a fort. The Irwell afforded power at an early date for mills, but it was not till after 1720 that the "vadys and rokkys" that obstructed its navigation were removed, and the river made navigable to the city by means of weirs and locks.

In the south-west of England, two inland towns besides Bath have maintained more or less importance since Roman times. These are Winchester and Dorchester, and along with these may be mentioned Salisbury, the modern representative of Sorbiodunum, though on a slightly different site. The natural features, all very similar, to which these three towns owe their importance have been already referred to (see vol. ix. pp. 80, 81). All the other stations of the itineraries in south-western England are identified with places now quite insignificant, unless Horsley's identification of Vindomum with Farnham be accepted; but one of them, Calleva Atrebatum, now Silchester, must in Roman times have been a centre of very considerable importance. Its Roman remains cover an extent of 80 acres, and in Roman times it was a meeting-place of roads from London, Cirencester, Salisbury (Old Sarum), and Winchester.

In Wales and Monmouth and the adjoining counties, three principal routes are given in the Itineraries—one along the southern maritime tract to Carmarthen, one along the northern maritime tract to the Conway river, and one running from south to north, east of the Welsh mountains, connecting the first route with Wroxeter and Chester. The Roman ferry across the Severn appears to have been about the place where the estuary begins to expand, in the neighbourhood of the present tunnel. The landing-place on the English side is not definitely ascertained, but on the Welsh side it must have been about Portskewet, for the first station on that side, Venta Silurum, a very important one, has been clearly identified with Caer Went, on a height immediately above that village. From that station the southern road running west appears to have touched four seaports, all of which are seaports at the present day, or have a representative immediately adjacent. The first of these seaports was Isca Silurum, remains of which are found at Caerleon, on the Usk, from which the station took its name, the seaport on which, however, is no longer at Caerleon, but at Newport, a short distance lower down. The other three seaports are Nidum (Neath), Leucarum (Loughor, or, in Welsh spelling, Llwchwr), and Maridunum (Carmarthen). In the north the road took a more inland course, its line being apparently determined, not by the ports, but by the fords. Only two stations west of Chester are mentioned in the Itineraries, Varæ (Bodfari) and Conovium (the "Conway" station, placed by Horsley at Caerhun). Probably this road was afterwards continued to Carnarvon (Segontiacum), which is mentioned in the Notitia, but not in the Itineraries or by Ptolemy.

The road leading from the south to Wroxeter started at Caerleon, and first followed the Usk valley. The intermediate stations on it are identified with Usk, Abergavenny, Kenchester (north-west of Hereford), and Leintwardine (crossing-place of the Teme in north-west of county of Hereford). Two of these have still a certain amount of at least relative importance arising from their situation. Usk, in Roman times as now, was the starting-point of a road, now a railway, ascending the valley of the small stream that here joins the Usk river, and passing by Monmouth, Ross, and just north of the Forest of Dean to Gloucester. Abergavenny stands at a still better-marked node, the point of convergence of four valleys, the upper and lower Usk forming two of these (running respectively north-west and south), that followed by the railway to Merthyr Tydvil forming a third, and that by the Great Western line to Hereford the fourth. The other two stations have been replaced by modern towns at a greater or less distance from the ancient, their sites being now occupied only by insignificant villages.

So much with regard to the towns or more important stations which did exist in Roman times. It is in some respects even more instructive to consider shortly some of those which did not then exist. And from this point of view there is, perhaps, nothing more striking than the scanty indications of Roman settlement on the three great rivers, the Thames, Severn, and Trent, above the limits reached by sea-going vessels. True it is that Roman stations, as we have already seen, are mentioned in the Itineraries at points far from the mouth on all these rivers; but all of them seem to have been mere crossing-places, and, except in the case of Wroxeter, there are no remains to show that they were of any great importance. Pontes, on the Thames, whether at Old Windsor or Staines, was merely the crossing-place on the road to Silchester. The name of the station, Ad Pontem, on the Fosse Way, together with the distances mentioned in the fifth Itinerary, makes it extremely probable that there must have been a station at a crossing-place of the Trent about Farndon, just above the islands enclosed by the two arms of the river, on one of which now stands Newark. The station must have been on the right bank, as there is no mention or indication of any other crossing of the Trent on the way to Lincoln, and no trace of any Roman road running north on the left bank of the river. There must, of course, have been some population on that bank of the river, but that population seems to have been very scanty. The absence of all traces of the station at which the river was here crossed seems to justify the inference that there was no such population on the left bank as to give to the station any great importance. At Wroxeter it was different, but the difference was not due to any additional value given to the site by the navigation of the Severn, but to the fact that the station at this ford was the point of convergence of roads from the south-east (London), the north (Chester), and the south (Caerleon and the Severn estuary).

Of course we have other evidence of the existence of Roman towns and settlements than the fact of their being recorded by one or other ancient writer. There is the evidence of names and remains. There are, it is said, 119 -chesters or -cesters, or some other form of the Roman castra, in Domesday, and it is probably fair to presume that all of these represent Roman towns. There are none of these, however, in the course of the Trent. The equivalents of the Roman *strata* are more doubtful signs of a Roman origin, but there is no name of this root met with in ascending the river till we come to Stretton, near the mouth of the Dove (the valley containing Uttoxeter). On the Thames between Cirencester and London, the only name indicating a Roman origin is Dorchester, and the Roman remains found here confirm the indication. Possibly, seeing that it is not mentioned by any ancient writer, the place is of late Roman origin. In any case, its existence on the banks of the Thames is no sign of extensive settlement on these banks, for it also was only a crossing-place—from the vale of Aylesbury, north of the Chiltern hills, to that of the Ock, in Berkshire. There are several "fords" about this part of the river, and the name Shillingford, exactly at the mouth of the Thame, would indicate that there was once a ford close to Dorchester. Roman remains have also been found at Sinodun hill, on the opposite bank.

Between Wroxeter and Gloucester there is also only one -cester—Worcester. Here, however, there are no Roman remains, though an old parchment, Camden tells us, boasted that it once had Roman walls. Probably it too was of late Roman origin, and if Prof. Thorold Rogers was right in saying (I don't know on what authority, except perhaps on the presumption that Droitwich is the Salinæ of the anonymous writer of Ravenna) that the Romans undoubtedly made use of the Worcestershire salt deposits, it is possible that the salt was conveyed down the Severn from Worcester.

All these indications of Roman occupation on the banks of the three great rivers

of England are, however, very scanty, and the absence of others would seem to justify the conclusion that in Roman times the valleys of these rivers were very thinly peopled. In all probability they were still, for the most part, unreclaimed marsh and forest.

If that was so, that single fact implies that the conditions under which towns, having practically ceased to exist in England, arose again after four or five centuries of village life, were to a large extent different from those under which they had been created by the Romans. During this long interval, an interval as long as that between the Wars of the Roses and the present time, but of which our only record is a story, and that imperfect, of wars between Angles, Jutes or Saxons, and British, between Saxons and Saxons or Angles, and between English and Danes, the great work of reclaiming the land, making it fit for agricultural settlement, must have gone on incessantly. Great numbers of the villages to which continental invaders after the departure of the Romans gave their names must have existed in Roman times, but multitudes of others must have received their names from these settlers through the original right of first occupation. And it is to be noted that when towns did come into being under these circumstances, they would grow; they would not be created. They would serve in some way local convenience, and increase from villages to towns in proportion as they did so. On the other hand, the Roman towns or more important stations on the great roads appear to have been established merely with reference to military and administrative convenience, and without any special regard to the trade requirements of the districts in which they were situated. Some of the more important towns, such as London, Lincoln, York, Winchester, Bath, Gloucester, and others, had their sites determined by natural conditions which have made themselves good throughout the history of this island. These were almost of necessity fixed points in any network of roads constructed for military purposes. But between such points the roads were laid with as much directness as the state of the country permitted, and no deviations seem to have been made, even for the sake of passing through important mining districts. Though pigs of lead with Roman inscriptions, dated in the sixth year after the invasion of Claudius, have been found in or near the Mendip hills, showing that the lead-mines here were worked from the very beginning of the Roman occupation, the Fosse Way is laid so as to run to the east of those hills, the mines in which were served by a mere vicinal road. So also, if Ariconium in the thirteenth Iter is rightly identified with Ross, the distance to Gloucester given in the Itineraries does not admit of any deviation into the mining district of the Forest of Dean, the produce of which must also have been carried along vicinal roads, or possibly on pack-animals by mere tracks.

A few important places having thus determined the direction of the main roads, the intermediate stations—which became, in some cases at least, the nuclei of considerable towns—had their sites necessarily determined by the direction of the roads, and only in a secondary degree by local circumstances, and these determining local circumstances were regarded rather from the military and administrative than the commercial point of view. Hence it is that, while many of the more important Roman towns have their modern representatives on the same site or a site immediately adjoining, many others have utterly disappeared, or have given place only to insignificant villages.

Nevertheless, there may have been reasons in certain cases why new towns should grow up under new conditions on or near the sites of some of these intermediate stations. This is notably the case with ford towns or stations. The position of intermediate Roman stations on rivers seems to have been determined rather with reference to the convenience of crossing the river by fords or bridges

than with reference to the use of the river as a waterway. But when the termini of the road made it convenient to cross by the lowest ford, that was often almost identical with the head of navigation. Hence, when a river came to be used as a waterway, a town would naturally grow up on or near the site of a previous ford-town. Thus Camboritum (Grantchester), the predecessor of Cambridge, was, as its name implies, originally a ford-town, but may have gradually acquired importance as a town at the head of navigation. Moreover, as Mr. Loftie has pointed out in his 'History of London,' fords are apt to occur at expansions of a river immediately above more contracted and deeper parts of the course, and these contracted parts are those which it is easiest to bridge; and so an original ford-town may grow in importance through its convenience as the starting-point of down-stream navigation, and then acquire still greater consequence through being made a bridge-town.

In some cases the deserted shells of Roman towns were themselves reoccupied.* Chester, for example, which seems to have been abandoned for three centuries after the victory of Æthelfrith about the end of the sixth century, was reoccupied by the daughter of Alfred in the beginning of the tenth century.† Carlisle had already been reoccupied by the English when it was destroyed by the Danes in 877; but Freeman conjectures that it was desolate two centuries later, when it was repeopled with English and Flemish colonists by William II.‡

In other cases an adjoining site became that of the succeeding town, probably for no other reason than that it was easier to utilize the material of the older town on an adjoining site than amidst the ruins of the previous town. Sometimes, however, some neighbouring site may have presented a distinct advantage in the eyes of both Saxons and Normans which was held of little account by the Romans. While the Romans seized on positions of great natural strength for their more important stations, such positions were of less consequence to them after they had established themselves, when they could rely confidently on their power of fortifying any position that it might be convenient for them to occupy against any attack that was likely to be made upon it. The Saxons, on the other hand, in their wars against the British and against each other, sought to turn to account every position of natural strength. Hence places that had eminences suitable for strongholds became in many cases the nuclei of their towns, and Saxon strongholds were frequently succeeded by Norman castles. Such probably was the reason why Wroxeter gave place to Shrewsbury and Caistor to Norwich,§ though in this latter case the original nucleus of the new town was the ford of the Yare (Conesford), to the south of the castle hill. Some of these Saxon strongholds, at one time important, but owing their importance solely to facilities for defence which were afterwards of no consequence, sank into insignificance at an early date. Such, for instance, were Amesbury (Ambresbury, the city of Ambrosius) in Wilts, Badbury in Dorset, and Almondbury, near Huddersfield.

It has been stated above that when towns again began to grow up in England after centuries of village life, the geographical conditions affecting their development were essentially different from those of Roman times. But it must not be understood that these changed conditions were final. They continued to be modified in many ways, and in some cases, even before the great revolution

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* Freeman, 'History of the Norman Conquest,' vol. i. p. 15 n.; Loftie, 'History of London,' vol. i. p. 54.

† Freeman, vol. iv. p. 313.

‡ Freeman, vol. v. pp. 118, 119.

§ The actual mound on which the castle is built is artificial, but the ground rises considerably to the site of this mound from the rivers Yare and Wensum.

wrought by the application of coal to the production of steam-power, which has been the greatest town-forming influence in England, these modifications had their effect in the rise and fall of towns. But towns, once in existence, make a struggle for life. If conditions are changed, efforts are made by the inhabitants to adapt them to the new conditions, and towns accordingly may have owed their origin to conditions that have long since ceased to exist. In many cases, too, these conditions may not have been at the first strictly geographical, and even when they are geographical, the geographical advantage may often seem very slight in consideration of the importance of the town. When the population and industry of some district requires a town somewhere as a centre of exchange, perhaps an important centre of exchange, a very trifling circumstance may determine the exact site on which that centre grows up.

The first towns that are likely to grow up of themselves are centres of trade. These, of course, are preceded by seats of government; but such towns are frequently on sites chosen more or less arbitrarily, and the nature of the site may have little to do with their growth. With a geographical object in view accordingly, centres of trade may be first considered, and, with reference to their growth, navigable rivers must be a prime consideration at a time when internal communications of another kind are imperfectly developed. At the present day their importance in this respect is obvious enough in new countries, though we in England are apt to forget it, since railways have so completely put internal waterways into the background.

But, in the case of old English towns, the inquiry as to the influence of navigable rivers on their origin is often rendered difficult by our ignorance as to the condition of rivers at the time when the towns arose. We know that in some cases rivers were navigable in former times that are not navigable now, and, again, that rivers are now in some cases navigable to a greater extent than they were formerly. Acts have been passed at different times for the making now of one river, now of another, navigable up to a certain point, but these Acts do not prove that these rivers were not at some earlier date navigable to an even higher point. We are told, for example, by Gough, in his edition of 'Camden's Britannia' (1789), that the Trent had lately been made navigable to Newark; but we know from Domesday that this river was then navigable at least as high as Nottingham. Gough's statement, moreover, must mean that the Trent was then made navigable for larger craft to Newark, for Arthur Young, writing a little earlier (1770), states that flints were brought to Burslem from the Thames first to Hull, and then to Burton. Probably a similar meaning is to be attached to being "made navigable" in other cases also.

Prof. Thorold Rogers, in the course of his quarter of a century of researches into the history of prices from the fourteenth century downwards, collected a good deal of information as to the use of waterways in early times; and he informs us that in the fourteenth century the Thames, the Severn, the Lower Avon, the Cambridgeshire Ouse, the Humber, the Itchen, the Test, the Stour (which Stour he refers to he does not say), the Wye, and many other rivers, were navigable and navigated.*

The Thames, however, was not navigated to so high a point as it was subsequently. In the fourteenth and fifteenth centuries, and even as late as 1541, Prof. Rogers says in a later volume,† Henley was apparently the limit of navigation.

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* 'Agriculture and Prices,' vol. i. p. 663. I have substituted Lower Avon for "the Ouse on which Bristol was built."

† Vol. vi. p. 758.

Afterwards for about 70 or 80 years it was Burcot, a hamlet about 1½ mile from Dorchester, and there Prof. Rogers tells us he could still, in 1877, discover, from four or five ruts cut deep through the ground between the water and the high-road, where the pier must have been. Subsequently, either through improvements in the river itself or by the building of barges that could pass the shallows, the navigation was continued to Oxford, and even beyond it, for, though this is the limit of water-carriage in the instances that fell under Prof. Rogers's eye, Yarranton, in his 'England's Improvement by Land and Sea' (1677), speaks of Lechlade, the present limit of barge navigation, as at the head of the navigable waters of the Thames in his day.

In the case of the Severn, Prof. Rogers gives an instance from the year 1374 of the carriage by water of 1¾ fother of lead, first from Worcester down to Bristol, then up the Wye to Monmouth, its ultimate destination being St. Briavel's. No doubt this lead was originally from Wirksworth, for centuries the principal lead market in England, and in that case it may have been previously carried down the Severn from some higher point than Worcester, though this city, which is still the limit of navigation for the larger river-boats, was no doubt a more important trade-centre than any town on the river higher up. At any rate, there is no reason to believe that this was then the highest navigable point on the river. Yarranton mentions Welshpool as at the head of navigation in his day, which it continued to be for more than a century later, and he points out the importance of the navigation of this river for the conveyance of the "sow iron" of the Forest of Dean to the forges of Worcestershire, Shropshire, Staffordshire, Warwickshire, and Cheshire, counties, he says, in which "there never will be any want of pit-coals to work and manufacture the iron when once made into bars." At the same date the Wye was navigable to Hereford, but the Worcestershire Stour was not navigable. The making of it navigable was one of Yarranton's own abortive projects.

Of the relative importance of towns in past centuries we have only doubtful indications. Estimates of the population have been made on the basis of the subsidy roll of 1377, these estimates assigning to London a population of about 35,000, to York one of nearly 11,000, to Bristol one of 9500, to Plymouth and Coventry each about 2750, to Norwich nearly 6000, and to Lincoln a little more than 5000. Only three, Salisbury, Lynn, and Colchester, are credited with a population of between 4000 and 5000. Eight, namely, Beverley, Newcastle-on-Tyne, Canterbury, Bury St. Edmunds, Oxford, Gloucester, Leicester, and Shrewsbury are estimated to have had between 3000 and 4000, and the remaining towns with more than 2000 inhabitants are eleven in number, namely, Yarmouth, Hereford, Ely, Cambridge, Exeter, Worcester, Kingston-upon-Hull, Ipswich, Northampton, Nottingham, and Winchester. Twelve other towns are mentioned in the list. These are Newark, Wells, Ludlow, Southampton, Derby, Lichfield, Chichester, Boston, Carlisle, Rochester, Bath, and Dartmouth, the latter three of which are estimated to have had less than 1000 inhabitants.*

This list deserves a little consideration. It includes in all forty-two towns, of which nineteen were seaports, and at least fourteen were river-ports—seventeen, if we may include among the latter Shrewsbury, Hereford, and Winchester. (According to Prof. Thorold Rogers, the Itchen was navigable at this time.)

Among seaports, the high place belonging to Bristol is very noticeable. It is the port of a region which has always been one of the richest, agriculturally, in England, and one to which population had been also attracted at a very early

* These estimates are all from Macpherson's 'Annals of Commerce,' vol. i. p. 583, but the exact figures of Macpherson's list are converted into round numbers.

date by the working of the lead-mines of the Mendips. But its great importance is probably to be referred to its foreign commerce—above all, its commerce with Iceland and the north generally, which dates from the century to which the list belongs—that in which lived the first William Canynges, who began the rebuilding of the church of St. Mary Redcliffe. It was not a Roman town. In Roman times, no doubt, Bath served all the purposes of a seaport for this region; and from this list it would appear that as Bristol rose Bath declined. But if we account in this way for the importance of Bristol, it is surprising to find Southampton and Boston both so low in the list. Both of these were likewise important for their foreign commerce at this date, and another assessment list twenty years later gives a very different relative position to these seaports among English towns, although it does not afford the means of estimating the population. In this later list of 1397 we only get the amounts for which different towns were assessed, but in it we find that Boston and Southampton ranked respectively as fourth and tenth, instead of thirty-eighth and thirty-fourth, as in the list of 1377. Boston in this list is assessed at £300, Southampton at £113⅓; against £800 for Bristol.* About a century later, in the reign of Henry VII., Southampton, if we may judge by the amount of customs dues levied, had about the same relative importance as it now has among the ports of the south-east of England—ranking next after London, and separated by a long interval from the third in this respect, which was then Boston. Bristol then had the fourth place, coming next after Newcastle.†

Plymouth, notwithstanding the excellence of its natural harbour, was a place of comparatively recent growth in 1377. It is described by Leland as having been, in Henry II.'s time—about two hundred years before—a mean thing inhabited by fishers.

The position of Norwich, which comes next among the seaports, at the end of a waterway leading far into the interior of one of the richest corn counties of the kingdom, fully accounts for the important position that that town has always managed to retain. Lynn and Cambridge, on the Ouse, show the importance of the navigation of that river—a circumstance which in all probability led to the locating of the great fair of the eastern counties, the Stourbridge fair, which was largely frequented even down to the latter part of the eighteenth century, close by Cambridge.

Hull at this time was less than a hundred years old, but had already completely displaced its predecessor Hedon, which does not appear either in the list of 1377 or that of 1397. In Leland's time the harbour of Hedon had almost completely silted up, and though formerly the town had been nearly insulated by the subdivisions of the inlet from the Humber on which it stood, it was in his time approached by three bridges.

Nottingham is mentioned as a river-port, though the town itself is separated from the river by a mile or two of alluvial meadow-land, probably regarded as too valuable for sheep and cattle to be turned into sites for houses, especially since much better building land was to be got on the adjoining Bunter pebble-beds, under the protection of the castle crowning the chief height. In Domesday it is mentioned as guarding the waters of Trent and the road to York, and that the waters

* Cunningham, 'Growth of English Industry and Commerce: Early and Middle Ages,' p. 343.

† The total amount of customs dues levied during the reign of Henry VII. at London was £444,660; at Southampton, £170,200; at Boston, £57,600; at Newcastle, £45,800; at Bristol, £30,600 (Schanz, 'Englische Handelspolitik gegen Ende des Mittelalters,' ii. pp. 37–45).

of Trent are regarded as navigable waters is shown by the fact that a fine is imposed on any who should hinder the passage of ships. Whether the road to York is anything else than the Trent itself is not clear, but at a later time, at any rate, Nottingham derived additional importance from the fact that this was the crossing-place of the main road from south to north.

The towns in the list of 1377 that were neither seaports nor river-ports are—Coventry, Salisbury, Bury St. Edmunds, Oxford, Ludlow, Lichfield, and Chichester, besides the doubtful ones of Shrewsbury, Hereford, and Winchester. To these the list of 1397 adds Abingdon and Grantham, besides the seaports of Sandwich and Scarborough among the towns paying an assessment equal to that paid by Canterbury, Chichester, Leicester, and a number of others.

Among these Hereford, Ludlow, and Lichfield owed such importance as they possessed to their position in well-watered fertile plains or hollows at river-crossings. Of Salisbury, Shrewsbury, and Chichester nothing more need be said. About the time to which these lists refer Coventry was just beginning to be known as a manufacturing town. There is no geographical reason to be assigned for Coventry becoming either a manufacturing town or a centre of trade. It not only stands on no navigable river, but it is out of the route of the Fosse Way, which may be considered as giving some of its importance to Leicester, the nearest of its considerable neighbours. But its wealth and industry are amply accounted for by its special privileges. A wealthy monastery was founded here by Leofrick, Earl of Mercia, in the reign of Edward the Confessor. Early in the thirteenth century (in the second year of Henry III.), the charter for a fair was granted to it. Under Edward III. the original privileges of the monastery were confirmed and extended, no doubt through the influence of Queen Isabella, who possessed some land adjoining the monastery and afterwards surrounded by the walls of the town. The privileges conferred by Edward included exemption from several taxes for all lands assigned to the monastery, and these privileges, together with the wealth of the monastery itself, would serve to attract a considerable population. To so great an extent did the town depend on the monastery that, whereas at the time of the dissolution of the monasteries the population was said to have amounted to 15,000, in the third year of Edward VI. it had sunk to about 3000. On the other side of England Bury owed its importance to similar circumstances, though here additional consequence may have been given to it as a trading centre if it was then, as it is now, at the head of the navigation of the Lark. If so, the Lark again required to be made navigable about 1730, when an Act was passed for the purpose.

Oxford and Abingdon both owed their rise to the same cause, namely, the fact of their standing at crossing-places (fords) of the Thames. In the first of these that is indicated by the name, but Oxford already at this time was, of course, a place of note and wealth as a seat of learning. At the date to which the list now under consideration refers, Abingdon was nothing but a ford-town (with a very wealthy abbey adjoining, however). There were two fords at or near the town, the Borough ford and Culham ford, both somewhat dangerous; and the town had rivals at other fords lower down—one, as we have already seen, at Dorchester (Shillingford), and another at Wallingford, this last, at a somewhat earlier date, the most important of all. But, says Camden, "About the time of the dreadful plague which followed the conjunction of Saturn and Mars in Capricorn, and raged all over Europe, A.D. 1348, so many persons died here, that from being a populous town, and having twelve churches, it has now but one or two." "The inhabitants, indeed," he adds, "refer this desertion to the bridges built at Abingdon and Dorchester, over which the road was turned."

The importance of Grantham in the fourteenth century may be connected with that of the seaport of Boston. As Lincoln would be the inland centre in communication with that port for the northern districts, so Grantham would be the same for the midland and southern districts of the interior. The town lies on post-glacial gravel and sand, in a slight but well-marked hollow at the convergence of small valleys between middle and upper Lias sands and clays and marlstone rockbeds with ironstone. Whether the ironstone was already worked in 1397 I cannot say.

Among the more noteworthy omissions in these lists are Chester, Liverpool, Manchester, Leeds, Halifax, Wakefield, Sheffield, and Birmingham. The omission of Chester is fully accounted for by the fact that the whole county was excluded from the assessments as being under a separate jurisdiction. Most of the other towns were more or less noted for their manufactures of one kind or another, if not in the century of which we are now speaking, in that which followed, but it was long before manufacturing towns in England, merely as such, became populous places. Sheffield, we know from Chaucer, was already noted for its cutlery in the fourteenth century. It has continued to be so ever since, yet in 1615 it had a population of only 2200.* Leeds, Halifax, and Wakefield became noted as seats of the woollen industry in the fifteenth century. According to Anderson,† the industry had migrated from the southern and eastern counties to the valleys of Yorkshire on account of the abundance of water, fuel, and cheap provisions. No doubt, the vicinity of the supplies of the excellent Lincolnshire wool, which (in its much improved condition) is still so valuable a commodity in the manufacturing towns of Yorkshire, would also be an important circumstance in favouring these seats of the industry. But these places grew but slowly in population. This was largely because the industries referred to belonged to districts rather than to towns, spinning especially being carried on to a large extent as a bye-employment on farms. Rapid concentration in towns was brought about in most cases only when machinery worked by steam-power came to be employed in factories, though two or three inland towns so placed as to be the natural centres of trade for populous districts, while at the same time carrying on manufactures of their own, grew with exceptional rapidity.

At the first census there were only three inland towns in England, Manchester, Leeds, and Birmingham, with a population of more than 50,000, and all these belonged to this class. Manchester then had a population of about 89,000;‡ that of Birmingham, 73,700; and that of Leeds, 52,200.

According to Prof. Leone Levi,§ Manchester was known for its textile manufactures as far back as 1328, when a number of Flemish weavers settled there. Its site makes it the almost inevitable focus of all the roads leading across the Pennine chain to the south-east of Lancashire, as well as of others leading across detached parts of that chain. One road proceeds north-west to Bolton, and there forks so as to pass round an elevated patch capped by millstone grits, one branch going by Chorley to Preston, the other going to Blackburn. A more northerly road proceeds by Bury to Accrington between two similar outliers of the Pennine chain. Another runs north by east to Rochdale, then crosses the waterparting between the Roch and the Calder to the east of all these outliers, following the route of the railway to Todmorden and Halifax. Another goes north-east to Oldham, then east to

* Hunter's 'Hallamshire,' new edit. by the Rev. A. Gatty (1869), p. 148. In 1736 the total ascertained population was only 10,121 (*ibid.*).

† 'History of Commerce,' vol. i. p. 526.

‡ Including Salford.

§ 'History of Brit. Commerce,' p. 5.

Saddleworth, and then by a short and sharp ascent and descent passes across the millstone grit of Clowes Moss from the valley of the Etherow to that of the Colne with Huddersfield, the London and North-Western railway crossing this waterparting by nearly the same route in Stanedge tunnel, 3 miles long. Another road from Oldham crosses Clowes Moss with gentler slopes, though with more windings, more to the north-east, following nearly the route of the old Roman road by Slack to York. Eastwards from Manchester a road runs by Ashton and Stalybridge to Penistone, where it forks for Sheffield and Barnsley; and, finally, there are roads south-east leading to the valleys of the Dove and Wye in Derbyshire, as well as one across the high ground between these valleys, following somewhat the old Roman route to the ancient as well as modern lead-mining centre of Wirksworth.* A town so situated could not fail to become a centre of trade once population had grown up in the valleys to which these roads lead, but the development of industries on the east side of the Pennine chain was one of the conditions required for the full growth of Manchester. These facts help to explain the development of Manchester, such as it was, even before the rapid growth of its manufactures, consequent on the inventions first applied to the cotton industry. A survey of Manchester and Salford made in 1773 and 1774 enables us to estimate the effect which these inventions had on the population of this centre between that date and the census of 1801. The earlier date is a few years subsequent to the introduction of the spinning-jenny (invented 1764, patented 1770) and previous to that of the mule (patented 1779). In 1789 the first cotton-mill worked by steam was set in operation in Manchester. In 1773–4 the population ascertained for the two townships was 27,200;† in 1801 almost exactly 84,000 (being about 94 per cent. of the total population of the municipalities). But even since these inventions it is more as a business than as a manufacturing town that Manchester has continued to grow. The spinning-jenny and the mule were both to a large extent, perhaps chiefly, employed in country districts, and, as is well known, it is rather in the towns round about Manchester than in Manchester itself that the cotton industry is now, and has long been, carried on by steam-machinery.

With regard to Liverpool, which, like Manchester, is unmentioned in the lists of 1377 and 1397, and which, as is well known, was an unimportant place even in the early part of the seventeenth century, all that need be said is that its growth as a seaport was retarded by the same circumstances that kept back the growth of Manchester, on which its trade has always in a large measure depended.

On the east side of the Pennine chain, Leeds has a position somewhat analogous to that of Manchester on the west side, only the convergence, owing to the greater extent of open plain on this side, is less marked. On the west side, Manchester is the only point of convergence in or near the border of the more open part of the plain. On the east side, in addition to Leeds, such a situation is occupied by Sheffield, and in a less degree by Wakefield and Barnsley. It is probably, therefore, to be ascribed, at least in part, to this circumstance that Leeds has not grown so rapidly as Manchester, either before or since the beginning of the present century. In 1801, Sheffield was the only town besides Leeds with a population exceeding 10,000 in the West Riding of Yorkshire. Its population then amounted to 31,314; but this population does not correspond to that of the present municipal and county borough, which occupies an extensive area stretching 11 or 12 miles from north-east to south-west, nearly as large as the former parish of Sheffield, which in 1801 numbered 45,755 inhabitants. Though no other town in this district then had a population

* I have mentioned only such roads as existed before the close of last century.

† Wheeler's 'Manchester,' p. 249.

exceeding 10,000, there were some populous parishes, but most of them of great extent. Wakefield parish, with an area of 9311 acres, had 16,600 inhabitants, the borough (township) 8131 inhabitants. The only other township with more than 8000 inhabitants was Halifax (8886); but the parish of Halifax, which embraced all the Calder valley above the confluence of the Colne, extending westwards to the frontier of Lancashire, comprising an area about nine times as great as that of the present borough, had a population of 63,000.

Birmingham, the last of the three inland towns as having had more than 50,000 inhabitants at the first census, belongs to the region already referred to as having early attained celebrity for the working of iron. In Domesday it had only nine heads of families. Probably the district then was almost entirely forest, the part of the county to which it belongs having been, even in Camden's time, designated the Woodland, as distinguished from the Feldon or Fieldland south-east of the Avon. But in Leland's time it was already noted for the large number of its smiths. Yet the site occupied by it has neither coal nor iron, both of these materials having been got by the smiths, even in Leland's time, out of Staffordshire—in the close vicinity of Birmingham, however. The growth of the town may have been favoured by its position at a point almost equidistant between the navigable waters of the Trent, Severn, and Avon. It grew rapidly in the eighteenth century, in the latter part of which it had the advantage of canal communication with the coal-pits of Wednesbury, and with the Stafford and Worcester, ultimately also with the Trent and Mersey canal. Gough (Camden's editor) tells us that between 1741 and the time when he wrote (about 1789), it added 25,000 to its population.

One other inland manufacturing town is worthy of notice, not on account of its size, but on account of the persistence with which it has managed, in spite of all economic changes, to maintain its fame in connection with some branch or branches of the woollen industry for more than five hundred years. The town I mean is Kendal, situated in a beautiful but somewhat isolated valley at the south end of a lozenge-shaped patch of fertile alluvium. The fertility of its valley has always favoured the production of abundance of provisions, while the comparative isolation has kept them cheap, and this, no doubt, is one great cause that has promoted its manufacturing industry. The fact of its being a very plentiful and cheap place is noted by Arthur Young in 1770, and is amply borne out by the prices he gives (fat stubble geese, 1*s.* 4*d.* each; bread, that is, oatmeal cakes called clapbread, 1*d.* per pound; cheese, 3½*d.* per pound; beef, 2½*d.* and 3*d.* per pound; trout often 1*d.* per pound, etc.). Flemish woollen weavers settled here in the reign of Edward III., and its early manufactures, which have been rendered by Shakespeare and Scott familiar as a household word, are celebrated both by Leland and Camden, the latter mentioning that they were sent all over England. Though the valley is somewhat isolated, yet it lies on the south side of the high fell which separates the valley of the Eden from the rest of England, so that it is in easy communication with the south; and Young mentions that in his day all the Kendal manufactures were sent to London by land carriage, which, he says, was the longest stage for broad-wheel waggons in England. Among the manufactures of Young's time it is interesting to find mention made of "Kendal cottons," in the sense in which the term was used in the sixteenth century,* as the name of a fabric made of coarse local wool.† The woollen goods which it still produces are chiefly heavy fabrics,

* When "Manchester cottons" and "Welsh cottons" of the same kind were also celebrated.

† 'Tour in the Northern Counties,' vol. iv. pp. 131–136.

such as railway rugs. In 1801 the population of the town was nearly 7000, more than that of the Yorkshire Bradford. Of course it has not been able to vie in growth since that date with the towns on the coalfields, but it is still prosperous, its population showing an increase at every recent census. In 1891 it amounted to 14,400.

ON THE DISTRIBUTION OF EARTHQUAKES IN JAPAN DURING THE YEARS 1885–1892.*

By CHARLES DAVISON, Sc.D., F.G.S.

HALF a century ago, the foundations of Seismology as a science were laid by Mallet, when his celebrated paper on the "Dynamics of Earthquakes" was read before the Royal Irish Academy. Since that time many attempts have been made to represent graphically the distribution of earthquakes over the surface of the globe. One of the most successful, though not the earliest, of these seismic maps was that prepared by Mallet himself, and published in a reduced form in the 'British Association Report' for 1858. As the methods on which this map was constructed have been followed more or less closely in other and more recent maps of special districts, it may be fairly taken as a type of its class.

The chief principles adopted by Mallet were, that the area disturbed by each earthquake should be laid down on the map and coloured, and that the darkness of the tint covering the area should be roughly proportional to the intensity of the shock. As far as possible, he divided all earthquakes into three classes, the first consisting of great earthquakes, like that of Lisbon; the second of mean earthquakes, like those which are of not uncommon occurrence in Italy and at the east end of the Mediterranean; and the third of minor earthquakes, which take place almost daily in every quarter of the globe. The intensities of the tints representing an earthquake of each class were made proportional to the numbers 9, 3, and 1; and a single wash of the proper tint was laid down over the disturbed area in every case. Sometimes the known data were insufficient to determine the boundaries of these areas, and their radii for the different classes were then assumed to be 540, 180, and 60 geographical miles respectively. The most deeply tinted areas mark the regions where either the number or intensity or both of successive earthquakes was the greatest, but whether the darker tinting is due to frequency or intensity can only be determined by reference to the great catalogue on which Mallet founded his map.

The coloured areas exist principally in the form of bands of great but variable width, generally following the lines of elevation which bound the great ocean basins. As these are frequently the lines of mountain chains, and these again of volcanic vents, the seismic bands so far follow those in which active or recently active volcanoes are prevalent. The areas of minimum disturbance, according to Mallet, are the central districts of "great oceanic or terr-oceanic basins or saucers, and the greater islands existing in shallow seas."

Valuable as are the results thus deduced from Mallet's map, it is subject to one very important defect: it furnishes no information as to the exact seat of disturbance in any case. For instance, corresponding to the great Lisbon earthquake of 1755, nearly all Europe would receive a wash of colour. The tinting at some point of the map might conceivably be fairly dark, and yet few, perhaps no, earthquakes may have originated within many miles.

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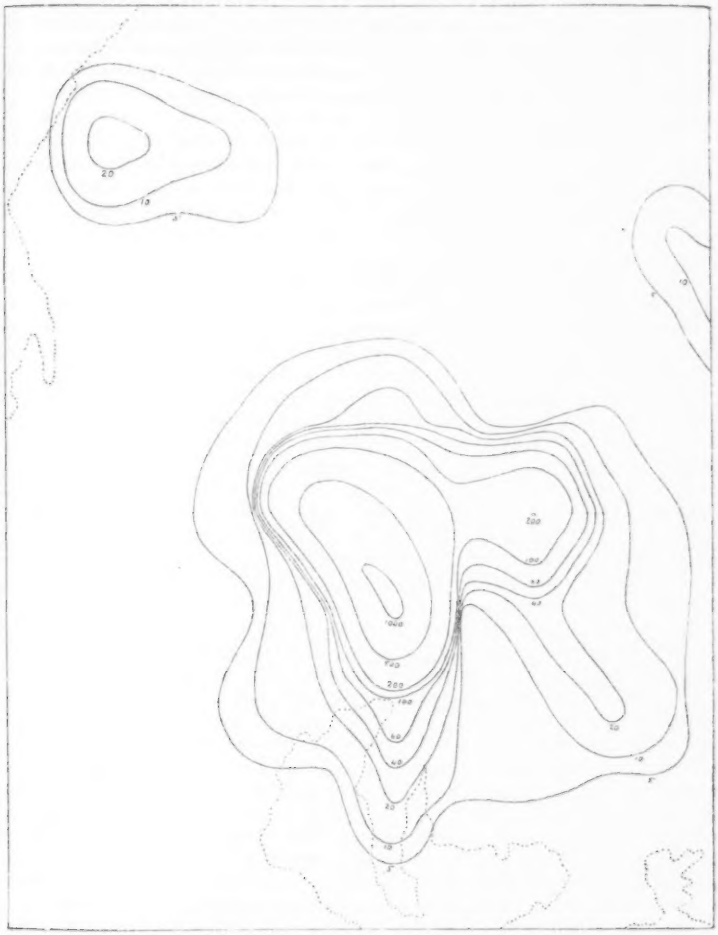
* Map, p. 564.

Thus, while Mallet's map is the result of enormous labour and great care, and was, indeed, the only kind possible in his time, it is clearly the product of an incipient science. As our knowledge extends, our inquiries inevitably become more detailed in their character; and as our measurements become more refined and our seismic catalogues more complete, so our maps will become more elaborate.



DISTRICT IN THE PROVINCES OF MINO AND OWARI.

I believe that all seismologists are now agreed that the general seismic maps of the future should indicate, not disturbed areas, but epicentres or centres of disturbance. There are few countries in which such a method of mapping is at present possible, but far in advance of all others in this respect stands the empire of Japan. While destructive earthquakes are unfortunately anything but rare in

that country, it is, on the other hand, favoured by the occurrence of almost innumerable minor shocks, more than eight thousand having been recorded and mapped during the eight years 1885–1892. For the admirable organization which has been created for their study, we are very largely indebted to our countryman, Prof. Milne; and one of his last acts before leaving Japan was to publish his great catalogue of Japanese earthquakes during the eight years just mentioned.* Some idea of the value of this catalogue, and of the immense labour involved in its preparation, will be evident from the statement that, though it contains more than eight thousand entries, it yet gives, with comparatively few exceptions, the epoch of every earthquake, the dimensions of the disturbed area, the approximate path of its boundary, and the position of its centre.

For the construction of seismic maps, the last is the most important element. The map of the whole country is divided by lines drawn north-and-south and east-and-west into a network of more than two thousand rectangles, the sides of which are respectively one-sixth of a degree of latitude and longitude in length. These rectangles are numbered consecutively, and for each earthquake is given the number of that one in which its centre lies.†

To the large "key-map" which illustrates the catalogues, Prof. Milne has added a reduced copy of it, showing the distribution of earthquake centres in Japan. In this the positions of the centres are indicated by small dots, but in two of the fifteen seismic districts into which the country is divided, the shocks were so numerous that the boundaries are represented as straight lines beyond the proper limits, as there would not otherwise have been room to insert all the dots. In one district, especially that to which the great earthquake of 1891 belongs, the dots are distributed uniformly over an area more than two degrees from north to south, and nearly two degrees from east to west, whereas the majority of the earthquakes originated near the centre of the district. Prof. Milne's map thus indicates the regions of greatest seismic frequency; but, as it does not show the details of the distribution very clearly, it seemed to me that a somewhat different method of representation might be employed with advantage.

This method consists, briefly, in drawing curves through the centres of all rectangles in which the same number of earthquake centres (or epicentres) lie. The curves so obtained are thus analogous to contour-lines. When they are grouped closely together, they imply a rapid change in seismic frequency; when they are far apart, they indicate a near approach to uniformity of distribution.

In practice the application of the method is not quite so simple. The number of epicentres in adjacent rectangles does not vary continuously. For instance, if we wished to draw what we may call the frequency-curve 10, we should find comparatively few rectangles which contain exactly this number of epicentres. But in two adjacent rectangles there might be eight and twelve epicentres respectively, and in this case the curve would be drawn so as to bisect the line joining the centres of the rectangles. Or there might be nine epicentres in one and thirteen in the other, and then the line joining the centres of the rectangles would be divided into four equal parts, and the frequency-curve would be drawn through the point of division nearest the centre of the rectangle containing nine epicentres.

In drawing isobaric and other lines, a similar method is of course adopted, but the interpretation of the frequency-curves is less simple than in these cases. It

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* 'A Catalogue of 8331 Earthquakes recorded in Japan between 1885 and 1892,' *Seismological Journal*, vol. iv. (1895), pp. i.–xxi., 1–367.

† Sometimes the centre is stated as lying between two adjacent rectangles. In such cases I have allotted one-half to each rectangle.

may be stated as follows: Let any point of the frequency-curve 10 be imagined as the centre of a rectangle whose sides run north-and-south and east-and-west, and are respectively one-sixth of a degree of latitude and longitude in length; then the number of epicentres within such a rectangle will be at the rate of ten during the epoch considered.

One or two defects, not so much in the method as in its application, should be referred to. If it should happen that the epicentres are not distributed uniformly between the centres of two adjacent rectangles, some error must arise from the assumption that they may be regarded as collected at the centres of the corresponding rectangles. But in the present case, as the area of the rectangles is so small compared with that of the whole country, the error can never be of much consequence, except perhaps in minute details. For even in the extreme case in which all the epicentres are grouped close to one side of the rectangle, their distance from its centre must be less than one-twelfth of a degree, and thus the error in the position of any curve drawn on the map must be smaller still.

Another defect arises from the fact that the rectangles are not of equal area throughout the map; for the breadth of a rectangle depends on the length of a degree of longitude, and this varies with the latitude. Thus in the north of Japan, in latitude 45° 30′, the area of a rectangle is about 92·8 square miles, and near the south, in latitude 30° 30′, about 114·3 square miles. This difference is not unimportant, and might have been allowed for, but the labour of making the necessary conversions would have been considerable, and would hardly have been repaid by the increased accuracy of the results. Regarding a rectangle in latitude 38° as the unit area, the effect of taking into account the varying length of the degree of longitude, would be to expand very slightly outwards all curves to the north of this latitude, and to contract all those to the south.

The interest and value of the map would have been much increased if the curves had been continued over the surrounding sea. But it seemed undesirable to attempt this for several reasons. It is difficult, for instance, to determine with accuracy the position of the epicentre when only part of the boundary of the disturbed area can be drawn. Another and more important reason is that, while some earthquakes are known to have originated at a distance as great as 50 or 60 geographical miles from the coast, it is only the stronger of such earthquakes that can be felt on the land at all, and still fewer that can be felt over an area large enough for the epicentre to be located even approximately. Thus the frequency-curves would have been accurate only in the immediate neighbourhood of the coast.

In the map of the whole country, curves are drawn corresponding respectively to 1, 5, 10, 50, 100, and 500 epicentres in a rectangle, and the intervals between the curves are shaded in different ways in order to show the distribution more clearly. During the eight years 1885–1892 no epicentre was situated within the unshaded areas, with a few exceptions in which single epicentres occur in isolated rectangles.

In several districts the earthquakes were so numerous that the details of the frequency-curves cannot be drawn accurately on so small a scale. This is especially the case in the provinces of Mino and Owari, which suffered so severely during the great earthquake of 1891. In the accompanying figure (p. 531) this district is represented. It is bounded by the parallels 34° 40′ and 36° 20′ north latitude, and by the meridians 2° 10′ and 3° 50′ west of Tokio. The curves correspond to 5, 10, 20, 40, 60, 100, 200, 500, and 1000 epicentres in a rectangle. The district being a comparatively small one, there is no sensible variation in the size of the rectangles. But, on the other hand, there may be some slight errors in the form and position of

the curves, owing to the assumption that the epicentres are supposed collected at the centre of each rectangle.

Prof. Milne remarks that his "map of earthquake origins or centres shows that the central portions of Japan, which are the mountainous districts where active volcanoes are numerous, is singularly free from earthquakes" (p. xv.). This feature in the distribution of epicentres is also brought out very clearly in the present map. The volcanoes, most of which are active, are indicated by black dots, and it will be seen that these are almost entirely absent from the more darkly shaded areas. It is also supported by the following brief analysis:—

Excluding those in the smaller outlying islands, there are 88 volcanoes. Some of these lie exactly on the border of two rectangles, and there are thus 96 rectangles in which volcanoes are entirely or partly situated, while there are 1476 rectangles on land without volcanoes. Now, epicentres lie in 22 (or 22·9 per cent.) of the volcanic, and in 527 (or 35·7 per cent.) of the non-volcanic rectangles. Counting by epicentres, however, the disproportion is still greater. The average number of epicentres in each non-volcanic rectangle is 3·57, and in each volcanic rectangle is 0·73; so that the number of epicentres in a non-volcanic rectangle is on the average very nearly five times as great as in a volcanic rectangle.

A large number of the Japanese earthquakes originate beneath the sea, especially, as Prof. Milne remarks (p. xv.), from "the face of the steep monoclinal slope which Japan presents towards the Pacific Ocean." As might be expected, most of the epicentres of *recorded* earthquakes lie near the land. For instance, the epicentres of 518 earthquakes were 5 geographical miles from the coast-line, 1539 at a distance of 10 miles, 6 at 15 miles, 146 at 20 miles, 30 at 30 miles, 14 at 50 miles, and 1 at a distance of 60 miles.

It is remarkable, however, that the coast-line itself is comparatively free from earthquakes. It will be seen from the map how many curves are entirely unbroken by the sea; how few of the curves corresponding to a large number of epicentres lie anywhere near the coast. The principal exceptions are at the two extremities of the country, towards the north-east at Nemoro, and the south-west at Kumamoto. In the four larger islands, the number of rectangles whose centres lie just within the coast-line is 412, and of these 131 (or 31·8 per cent.) were the seat of earthquakes. The total number of epicentres was 504, giving an average of 1·22 epicentre for each rectangle. The number of inland rectangles is 1150, and epicentres occur in 418 (or 36·4 per cent.) of these. The total number of epicentres in them was 4841·5, or an average of 4·22 epicentres in each rectangle.

Part of the island of Yezo, it should be mentioned, is sparsely populated, and it is possible that the seismic record there is less complete than in the rest of the country. Omitting this island, the number of coast rectangles is 307, of which 120 (or 39·1 per cent.) include epicentres. The number of epicentres is 470·5, or 1·53 in each rectangle. The number of inland rectangles is 883, and of those containing epicentres is 492 (or 55·7 per cent.). They contain 4615·5 epicentres, giving on an average 5·23 for each rectangle. Thus the main seismic activity of the inland rectangles is about three and a half times as great as that of the coast rectangles.

It is interesting to notice how this conclusion agrees with the theory of the distribution of earthquakes worked out so admirably by M. F. de Montessus.* The principal result at which he has arrived is that, in a group of adjacent seismic regions, earthquakes are most frequent in those in which the general inclination of the ground is greatest. The steep boundary-slope of a continental plateau is such

* "Relation entre le relief et la sismicité," Paris, *Acad. Sci. Compt. Rend.*, vol. cxx., 1895, pp. 1183–1186.

a region. When a coast-line coincides approximately with the boundary-slope, it is in general long and regular, and we should then expect to find it the seat of numerous earthquakes. But in the case of a coast-line broken and indented by the superficial irregularities of the plateau, the boundary-slope lies at some distance seawards, and the coast region should be characterized by an inferior degree of seismic activity.

The regions in which many and violent shocks occur are those in which the rate of terrestrial growth is most rapid. The coast-lines near which earthquakes are comparatively rare are thus the seats of less considerable change. At the same time they are the districts from which our measurements of the rate of secular elevation and depression have so far been derived. It follows, therefore, that our present estimates of the rate at which the development of the Earth's surface features is now taking place may be very much less than the true value.

THE MONTHLY RECORD.

THE SOCIETY.

The New Session.—The first meeting of the new session will take place on Monday, November 8, when Mr. F. G. Jackson will give an account of his three years' work in Franz Josef Land. At the second meeting the young Swedish explorer, Dr. Sven Hedin, will describe the results of his four years' travel in Central Asia. Lieut. Peary has promised to come to England in the end of November, and it is hoped that he will appear before the Society at one of the December meetings. It is expected that in the same month Mr. H. S. H. Cavendish, who has just returned from a remarkable journey in Somaliland, during which he travelled all round Lake Rudolf, will give some account of his journey to the Society. Other papers may be expected by Sir W. Martin Conway, on his recent expedition to Spitsbergen; Mr. E. A. Fitz Gerald, on his exploration around Mount Aconcagua; Dr. John Murray, on his Researches in the Scottish Lakes; Mr. H. Warington Smyth, on the Eastern Malay States of Siam. During the session a special meeting will be held in connection with the four hundredth anniversary of the discovery of the Cape route to India by Vasco da Gama. For other special features reference is made to the provisional programme of the session inserted in the present number.

EUROPE.

Dry River-bed near Malham, in Yorkshire.—The question of the exact source of the river Aire was not definitely settled until 1879, when an investigation proved that the waters of Malham tarn, which receives the drainage of Hard Flask and Fountain's fell, sink below the surface half a mile below its outlet, and reappear again in part at the foot of Malham cove and in part at Airehead springs, below the village of Malham. The stream has, however, not always flowed underground, but its dry river-bed can be distinctly followed during the interval between its disappearance and re-emergence. In fact, old accounts speak of occasions when the channel was filled with flood-water, which formed a magnificent cascade down the

sides of the cove. An excellent series of photographs, illustrating the course of the river-bed in its present state, appears in the *Proceedings of the Yorkshire Geological and Polytechnic Society* (New Series, vol. xiii. pt. 1), the same body which published the results of the investigation carried out in 1879.

A Mountain Observatory in the Pyrenees.—The *Bulletin de la Société de Géographie Commerciale de Bordeaux* (No. 13) contains an account of the high-level meteorological station established by the south-western section of the French Alpine Club at Gavarine, a village situated in the Hautes-Pyrenees, at an elevation of 4430 feet. Observations were begun in 1892, and the routine consists of three eye observations daily, filled in with various self-recording instruments, and a record is kept of avalanches, earth-tremors, migrations of birds, phenological changes, and so on. Apart from purely meteorological interests, the chief object is to co-operate with the observatory on the Pic du Midi de Bigorre in studying the variations in distribution of snow and glacier ice. The records of these elements have hitherto been very irregular and unsystematic, and the glaciers of the Pyrenees offer many points requiring careful investigation. M. Lourde-Rocheblade, vice-president of the section of the Alpine Club responsible for this work, and author of the paper under notice, does not give sufficient topographical information to enable a just estimate of the meteorological value of the observatory to be made; but it is interesting to note that the results of the observations have already led M. A. Millet, chief engineer of the Chemins de fer du Midi, to make experiments in the acclimatization of bees, which have attained very considerable success.

Dr. Thoroddsen's Explorations in Iceland.—In June and July this year Dr. Thoroddsen interrupted his systematic exploration of Iceland in order to examine the region affected by the great earthquake of last year, and in a letter from Edinburgh to the editor of *Petermanns Mitteilungen*, he furnishes a brief account of the results of that examination. The track affected was a somewhat irregular curve stretching from Tindafjöll to Ölves, surrounding the plain. But the whole strip was not set in motion at once, but sharply defined fragments were each in turn agitated separately—first the eastern section in the neighbourhood of Rangavellir, then the western near Ölves and on Lake Thingvalla. Many large fissures, two of them measuring about 10 miles in length with a width of 6 to 9 feet, were formed, and various other changes were wrought on the surface. Several of the older hot springs have disappeared, and new ones have been formed. In August Dr. Thoroddsen was able to resume his systematic work, and he then completed his survey of the coast-line with all its fjords and capes. Of the interior only the highlands north-west of the Langjökull remain to be explored, and this he hopes to do next summer, thus completing a task on which he entered in 1881, and which he has carried on regularly in every subsequent year.

ASIA.

The Danish Expedition to the Pamirs.—Lieut. Olufsen, the leader of the Danish Expedition of 1896 to the Pamirs, read an account of his journey before the Berlin Geographical Society in May last, which appears in the sixth number of the *Verhandlungen* for the current year, illustrated by a sketch-map. Another account, accompanied by a more detailed map of the Panj river, is published in the *Geografisk Tidskrift* (Nos. 3–4). Lieut. Olufsen approached the Pamir region by way of Osh and Gulcha, whence he reached the great Kara-kul by crossing the Taldyk and Kisil-art passes. The latter marks the point of transition between the damp climate of the Alai and the dry, clear atmosphere of the Pamirs. South of the pass, as little as six to eight per cent. of relative humidity was often registered. The direction of the wind was generally from north-north-east to east. From the

Kara-kul the expedition proceeded south-east to the Pamirsky post in the upper Murghab, and thence by the Alichur Pamir to Yashil-kul, and on over the Karghosh pass to the Pamir-darya. Here the less-known part of the route began. The Pamir-darya (often only 10 to 15 yards wide) was descended to its junction with the Panj or upper Oxus. The latter stream was followed down by a route along its northern bank, which had hitherto been considered impassable. During its passage through Wakhan the stream is often only 20 yards wide, but it is very rushing, and its water is of a dirty black colour. The rocks and glaciers of the Hindu-kush afforded a fine spectacle to the south, but the northern bank was less interesting, the way leading over swamps and deposits of drift sand, and being rendered very difficult by the many tributaries of the Panj, many bringing down a large volume of water. A considerable amount of cultivation is carried on, especially in the valleys of the tributaries. The Wakhan people are of middle size. Though said to be Iranian, they often showed Mongolian traits, perhaps through mixture with the Kirghiz. Their domestic animals are small on account of the severe climate, but the original report of their exceeding smallness seems to have been due to a misunderstanding. Their houses are built of stone, with flat roofs. Many ruined forts were seen, which were said to have been built by the Siah-posh Kafirs. The most difficult part of the route was that between Ishkashim, where the Panj makes its great bend to the north, and Garan, the district south of Shugnan. Here the granite rocks fell almost sheer to the water, and several horses were lost. The river is hemmed in into an extremely narrow channel, but widens out on reaching the province of Roshan, which, like Shugnan and Darwaz, struck the traveller by its fertility. Between Kala Wamar and Kala Wanj, the route led across the glacier passes of Odudi and Gushom, the passage of the moraines being both difficult and dangerous. The return was made from Karateghin, up the valley of the Surkhab, to the Taldyk pass.

Return of Mr. Landor from Tibet.—Telegrams from Bombay, published by the *Daily Press*, announce the return of Mr. Henry Savage Landor to India from an unsuccessful attempt to reach Lhasa. The reports state that the traveller underwent some terrible experiences, being abandoned by most of his men, and made prisoner by the Tibetans, narrowly escaping with his life. The following telegram has been received from Mr. Landor by the *Daily Mail*, whose representative he was :—"Naini Tal, October 22.—Arrived. Holding conference with Government. Point reached within four days' journey of Lhasa. Am suffering from injury to spine. Saved my diary, drawings, and maps. Am writing full account."

The Island of Cagayan Sulu.—A short account of the island of Cagayan Sulu, lying between the Philippines and Borneo, is contributed to the *Journal of the Asiatic Society of Bengal* (vol. lxv. part 3, No. 1), by Mr. E. F. Skertchly. The island is of volcanic origin, one extinct volcano rising to a height of 1105 feet, and a noteworthy feature is the occurrence of three lakes occupying the craters of old volcanoes. The outer wall of one of these has been broken through, so that the deep basin within communicates with the sea. The water of the two other lakes is fresh. The soil of the island is fertile, and much of the jungle has been cleared for cultivation. Although nominally under Spanish rule, the inhabitants would resent all attempts at interference. Their fighting force is estimated at from twelve to fifteen hundred men, and they have fortified one of the craters as a place of refuge. Fishing is practised with the aid of a root called *tubur*, which is used to stupefy the fish. The natives hold some remarkable superstitions, one of which relates to the "Berbalangs," who inhabit a village in the centre of the island, and are held in great fear by the rest of the inhabitants. They are believed to live partly on human flesh, and to have the power of assuming astral bodies,

which enter houses and feed on the entrails of their occupants. Mr. Skertchly paid a visit (alone) to their village, but found it deserted, although hot rice was standing in basins in the houses. By a strange coincidence, the death of a native occurred at the same time, under unexplained circumstances, in an isolated house in the neighbourhood, barred on the inside.

The Ob and Yenesei Expedition.—The trading expedition despatched this summer to Siberia by Mr. F. W. Popham by the sea-route has returned after a successful voyage, and the hopes entertained of establishing a permanent market for British goods in those regions have thus received a decided encouragement. No fewer than eleven steamers took part in the expedition, forming a larger fleet than had ever before traversed the once dreaded Kara sea at one time. The vessels sailed in two detachments; but, after an easy course, assembled at Khabarova, in Jugor straits, where a coal-ship was in waiting, and made the passage of the Kara sea in company. The water was found to be shallow, and many sandbanks not marked on the charts were discovered. Careful soundings were made, which should prove of much value to future navigators. After passing White island the fleet divided, part going up the Gulf of Ob under the command of Captain Tinkler of the *Naranja*, and the remainder making for the mouth of the Yenesei. Proceeding carefully up the centre of the gulf, new and unmarked banks being constantly discovered, the Ob detachment reached Nakodha bay, a desolate spot at the mouth of the Ob river. Four tugs and four grain-barges were already in waiting, and an exchange of commodities at once commenced. In fourteen days about 2000 tons of wheat, 1000 tons of oats, and 1000 tons of other grain were taken on board in exchange for the outward cargo of brick-tea, preserved fruits, rice, hand-tools, steel rails, etc. Brick-tea, which apparently formed the most important item, is allowed to enter Siberia on payment of a much lower duty than that charged in European Russia, and the comparative cheapness of its carriage by the water-route is likely to seriously affect the caravan trade between China and Siberia overland. At the Yenesei, where the outward cargo was also successfully disposed of, three paddle steamers were left to ply on the river, two having been ordered from Yeneseisk and Irkutsk respectively. One of the most satisfactory points is the amount of grain sent down to meet the expedition from Western Siberia. The establishment of such a trade should give a decided impetus to the development of that region.

Hydrography of the Great Plain of China.—The Hungarian geologist, Dr. Lugen von Cholnoky, has begun his investigations on this subject. In the middle of February he repaired to Hangchau-fu in order to study the embankments which shut off the old Yangtse delta from the sea, and to make observations on the bore of the Tsien-tang. Detailed notes of his journeys and investigations are expected to be given shortly in *Petermanns Mitteilungen* from letters of Prof. von Lóczy.

AFRICA.

Mr. Cavendish's Expedition to Lake Rudolf.—Mr. H. S. H. Cavendish, a young Englishman, who set out in September of last year on an expedition through Somaliland to Lake Rudolf, has just returned to this country after accomplishing a most successful journey. From Berbera he proceeded southward to Lugh, on the Jub river, whence he made his way westwards to Lake Stefanie. About 100 miles east of the lake he discovered a remarkable salt crater 1300 feet deep, while to the southward of it (as also subsequently to the west of Lake Rudolf) a bed of good coal was met with. Passing to the northward of Lake Rudolf, Mr. Cavendish was struck with the size of the Nianam river, the identity of which with the Omo had already, as mentioned in our last number, been

demonstrated by Captain Bòttego. The country west of the lake, as seen from a mountain 5000 feet high, is described as a mass of uninhabited mountains. Between these and the lake-shore, however, is a flat plain 50 miles wide, which, as noticed by the Italian travellers, accounts for the fact that too great a width was assigned to this part of the lake by Von Höhnel, who merely surveyed it from the opposite shore. The plain is, however, according to Mr. Cavendish, often flooded by the lake-water to a considerable distance. Like Captain Bòttego, the English traveller continued his march along this western shore of the lake, but, instead of turning back at the mouth of the Tirgoll river, he kept on in a southerly direction, and thus made perhaps the most interesting discovery resulting from his journey, viz. that the Teleki volcano at the southern extremity of Lake Rudolf has been completely shattered by a recent convulsion, nothing now remaining but a plain of lava. It may be remembered that when Dr. Donaldson Smith passed to the eastward of the lake, the volcano seemed to be very active, sending up great clouds of smoke. On his further journey to Mombasa by way of Lake Baringo, Mr. Cavendish discovered a new lake, in which had been another volcano, but this has now shared the fate of Mount Teleki. We hope to hear from Mr. Cavendish a full account of his journey at an early meeting of the Society.

M. Foa's Expedition in Central Africa.—Writing to us from Abercorn, at the south end of Lake Tanganyika, in July last, M. Foa announces the safe arrival of himself and his caravan at that point. He had deviated, *en route*, from the usual road to Tanganyika, and explored the Awemba country, mapping the course of the Chozi and Chambezi rivers, hitherto shown incorrectly on the maps. After making some astronomical, zoological, and ethnographical observations on Lake Tanganyika, M. Foa hopes to proceed to the Congo river, and thence to French Congo, by new routes.

The French in the Lake Chad Region.—The latest news of M. Gentil, published in the French papers, states that that explorer began the last stage of his journey to Lake Chad in May last, taking with him the steamer, the *Léon Blot*, intended for the navigation of the lake. Five permanent posts had been established between the Ubangi and the Shari. Meanwhile a commercial mission to the same region has been entrusted to M. de Behagle, who, with his second in command, M. de Mézière, recently left Loango *en route* for Brazzaville by way of the Kwilu. Both explorers already possess some experience of the country to be traversed, having accompanied M. Maistre on his journey to the Niger basin. They are said to be taking with them a large quantity of merchandise for exchange with the natives.

The Deposits of the Nile Delta.—The *Proceedings of the Royal Society*, No. 369, contains a second paper on this subject by Prof. Judd, forming a second report of the "Delta Committee" of the Royal Society. The first report (*Proc. R.S.*, No. 240) was noticed in our vol. viii., 1886, p. 189. This gave an account of borings which reached a maximum depth of 84 feet without touching the rock on which these deposits lie, and from which the Nile valley was originally excavated. With the co-operation of various military and railway authorities, the committee has since carried out further borings with a Legrand-and-Sutcliffe boring apparatus at a selected station in the neighbourhood of Zagazig, and a depth of 345 feet below the surface has been reached, still without any indication of solid rock. The deposits passed through, however, are of considerable interest, and Prof. Judd incorporates in his paper reports on the lithological characters by Dr. Karl von Zittel, of Munich, and on the scanty fossiliferous yield, by Prof. Rupert Jones. From the surface to a depth of 115 feet, the strata passed through in the new Zagazig boring—which, it should be mentioned, was carried out under the superintendence of Captain

Dickenson, R.E.,—closely resembled those described in the previous report; but at that depth a remarkable change occurred, the blown sand and alluvial mud of the Nile suddenly giving place to masses of shingle and sand, which prevailed down to the greatest depth reached, except at 151 feet, when a band of yellow clay 2 feet thick was passed through. Specially coarse shingle beds, some containing rounded pebbles up to the size of a hen's egg, were met with at depths of 121, 160, 175, 190, 208, 250, 265, and 270 feet. This boring is compared with one made at Rosetta by Mr. T. E. Cornish, C.M.G., director of the Alexandria waterworks, which showed the same sudden change, but at a depth of nearly 144 feet. The surface of these gravelly deposits, which were evidently laid down under conditions totally different from these which prevailed while the delta deposits were formed, seems accordingly to be very irregular, and the determination of their geological age is a problem of the greatest importance. Sir Samuel Baker suggests that the "turtle backs" of this region, patches of sand which appear like islands in the wide expanse of dark alluvium, may be parts of this original floor; but it is possible that they may be only lenticular masses of blown sand, alternating with the alluvial deposit. Unfortunately, all attempts to obtain contemporary fossils have been fruitless, although derived fossils are in some cases abundant. The spot where the Zagazig boring was made is directly opposite to the Great Wady (W. Tumilat), which opens on the delta from the east, and it is therefore possible that much of the gravelly material may have been brought down by this tributary rather than by the main stream of the Nile; hence the section obtained may not be so good an average sample of the sub-delta formation as it might have been. But there is little doubt that we have here a series of deposits which must have been laid down when the land was at least 100 to 300 feet higher than it is at present, and when the lower Nile, instead of forming an alluvial flat, was depositing coarse sands and gravels. Upon this very uneven surface the alluvial sands and muds of the delta were deposited as the surface gradually sank below the level of the Mediterranean.

Alfred Kaiser's Journey in East Africa.—Dr. Schöller, whose journey to the Victoria Nyanza in 1896 has been more than once referred to, was accompanied by Herr Alfred Kaiser, who appears to have undertaken the scientific work of the expedition, while Dr. Schöller travelled mainly for purposes of sport. Herr Kaiser has now returned to Germany with extensive scientific collections, and a short sketch of his journey appears in the twelfth number of the current volume of *Globus*. One of the principal objects of the expedition was the exploration of the great East African valley between Lakes Manyara and Naivasha. Proceeding by way of Kilimanjaro and Great Arusha to Simangori, north of Manyara, the travellers made their way northwards along the valley floor towards the Natron lake. An attempt to ascend the active volcano Doenyo Ngai was frustrated by the attack on the party by a rhinoceros, by one of which animals Herr Kaiser had previously been badly wounded. From the Natron lake the travellers followed the Guaso Njiro, which enters that lake after breaking through the wall of the valley from the north-west. Reaching Kavirondo, Herr Kaiser fell ill, and was unable to accompany Dr. Schöller to Uganda. He returned to the coast by way of Lake Naivasha, in the neighbourhood of which he continued his examination of the "rift valley." It is said that his researches will throw new light on the question of its mode of origin. The scientific results of the journey include careful topographical surveys, a number of mountain profiles, and collections of objects relating to botany, geology, and ethnology.

AMERICA.

The Utilization of Niagara.—Mr. T. Commerford Martin contributes to the *Proceedings of the Royal Institution* a very readable abstract of a lecture on the

gigantic engineering works, already in part carried out, for collecting and distributing part of the vast energies of Niagara Falls. A clear and non-technical description is given of the power installation at work on the American side, with its intake canal adequate to the development of 100,000 horse-power, the gigantic wheel-pit cut out of the rock to accommodate the 5000 horse-power turbines, and the colossal dynamoes which convert the energy into electricity. It is proposed to carry out similar works on the Canadian side, and when both stations are in operation it is estimated that no less than 350,000 horse-power will be available, a quantity which, although it only represents one-twentieth of the whole power supposed to be locked up in the falls, is nevertheless calculated to mean a saving of two millions sterling annually to New York State alone for motive-power. The geographer and geologist may find instructive information in the minute studies of the work of Niagara incidental to this immense undertaking.

The Mesa Encantada of New Mexico.—We learn from *Science* (September 17) that a survey of the "Enchanted Mesa," or Mesa Encantada of New Mexico, has been made by a party sent out by the United States Bureau of Ethnology. As we have already mentioned (*ante*, p. 214), an expedition to this mesa or sandstone tableland—the summit of which, according to native tradition, was once the site of an Indian settlement—was undertaken a few months ago by Prof. W. Libbey, who appears to have made a successful ascent, but without finding evidence of occupancy. A party, composed of Mr. Hodge, Major Pradt, and others, has since ascended the mesa, which was found to attain a height of 431 feet above the plain. Several potsherds, two stone axes (broken), and one or two other articles were found on the narrow crest, while abundant potsherds, etc., were seen in the talus swept down from the summit. All vestiges of the ancient trail ascending the talus have vanished, but some traces of the hand and foot holes in the rock above were discovered. A survey of the mesa was made, and photographs taken by the party.

Boundary between Mexico and British Honduras.—A parliamentary paper has lately been issued (Treaty Series, No. 6, 1897) relative to the boundary between Mexico and British Honduras, accompanied by a map on which the accepted line is clearly laid down. The treaty regulating the boundary was signed on July 8, 1893, but was supplemented in April last by an additional article, while the ratifications of the whole treaty were only exchanged on July 21. In the treaty concluded between Great Britain and Guatemala in 1856, a line was agreed upon, as part of the western limit of British territory, which should run due north as far as the Mexican frontier. As, however, this had not been precisely defined, while the boundary between Mexico and Guatemala, as agreed upon in 1882, depended to some extent on the position of the British frontier, the need clearly existed for an agreement between this country and Mexico on the subject. As now defined, the boundary runs thus: Beginning at the strait which separates Ambergris cay from the mainland of Yucatan, and passing between two small cays lying north-west of the former, it afterwards coincides with portions of the following parallels and meridians: 18° 10′ N., 88° 2′ W., 18° 25′ N., 88° 18′ W., 18° 28½′ N. This brings it to the mouth of the river Hondo, the deepest channel of which is followed—Albion island being left in British territory—as far as the junction of Blue creek and Booth's river. It continues up Blue creek as far as the meridian of Garbutt's falls, which forms the northern part of the boundary between British Honduras and Guatemala, running then south along this meridian to the point where the three boundaries intersect. The clause added during the present year secures to Mexican vessels, in perpetuity, the free navigation of the strait between Ambergris bay and the mainland, and of the territorial waters of British Honduras in general.

Influence of Physical Conditions on Economic Development in Tropical America.—In a short article contributed to the first quarterly *Bulletin* of the American Geographical Society for the current year, Mr. F. C. Nicholas draws attention to the importance to intending settlers of a knowledge of the ways in which atmospheric, physical, or geological conditions affect the healthiness, and consequent capabilities of development, of different areas in Tropical America. It is the want of this knowledge which has brought about the great sacrifice of human life in the endeavour to open up certain localities, while other vast regions capable of supporting a large population have remained almost unoccupied. It is, of course, the lowlands which should be avoided as a general rule, but there are exceptions in particular cases. One of the principal conditions needed is the free circulation of the atmosphere, either through the trade winds or local currents, and this is largely affected by the disposition of mountain ranges. Zones of stagnation are usually caused by abrupt unbroken ranges lying in the path of the trade wind. Good natural drainage is of the greatest importance, and excessive rainfall, though otherwise disadvantageous, is no drawback where this is present. Geological conditions should also be studied with care. Swamps often occur where troughs are formed by tilted strata, or where impervious underlying strata form basins. Recent alluvial deposits are as a rule dangerous; but older alluvium, if well drained, is often desirable. A sketch-map is given showing roughly the distribution of favourable and unfavourable districts, but on too small a scale to be of much practical value. The unfavourable districts are, of course, as a rule those along the coasts, but much of those of Central America, especially towards the Pacific, and that of Venezuela, with the exception of the Orinoco delta and the shores of the Gulf of Maracaibo, are regarded as suitable for settlement.

Tierra del Fuego.—The September number of *Petermanns Mitteilungen* contains a brief preliminary account of the work of the expedition to this archipelago under the command of Dr. Otto Nordenskjöld in 1895-96. The account is accompanied by a map on the scale of 1 : 1,600,000. With regard to the scientific results of the expedition Dr. Nordenskjöld can say little, as the considerable zoological and botanical collections have not yet been worked up. Work was done with the drag-net and trawl at thirty-seven stations, and land, fresh-water, and coast forms were collected at forty stations. From a geological point of view, the fossils of animals and plants that have been collected point to a Tertiary climate, somewhat but not much warmer than the present. Afterwards an ice-period supervened. The ice completely covered Tierra del Fuego, and filled the straits of Magellan, but nowhere reached the present Atlantic coast north of 52° S. At the end of the glacial period Tierra del Fuego was about 200 feet lower than at present; but elevation seems now to have ceased, or, at least, to be going on very slowly.

Cable-laying on the Amazon River.—The *Proceedings of the Royal Institution* contains a brief abstract of Mr. Alexander Siemens's lecture on the above subject, delivered on May 15, 1896. Belem, the capital of the state of Pará, has been connected by a sub-fluvial cable with Manaos, the capital of Amazonas, and the intermediate stations, and branch cables from Pará to Cametá on the Tocantins, and from Santarem to Alemquer, serve to open up communication with a large area of what has hitherto been almost inaccessible country. The preliminary surveys were made during the hottest season, in the month of October, while the cable was laid during January and February after the rainy season had begun; the meteorological observations made on board ship are accordingly of considerable interest. Observations of river temperature during the cable-laying expedition show a remarkable uniformity, indicating rapid movement of a very large body of water. The abstract does little more than mention many points of great interest

with regard to the Amazon and its tributaries—the steep banks and flat bottom characteristic of the channel through the Tabatinga or hard clay banks of the narrows; the extraordinary narrowing at Obidos, where the whole volume of water passes through one channel a little over a mile wide, at an average rate of three knots, the depth obtained by Thomson sounder being 58 fathoms; the remarkable navigation of the "furos" or channels connecting the Pará river with the Amazon; and the peculiarities of the rubber trade of the islands of the lower Amazon, centred at Breves. Accurate and extensive information has evidently been collected on these and many other things in the manner characteristic of expeditions of this kind, and in addition collections were made, particularly during an enforced delay at the mouth of the Baiassu, not far from Breves, by two naturalists from the British Museum. It is interesting to note Mr. Siemens's remark with reference to photographs illustrating the luxuriance of the vegetation met with everywhere, that "no attempt will be made to describe it, as that has been done to perfection in the classical works of Bates and Wallace; . . . hardly anything new can be added to their description of the general features of the Amazon valley."

The Argentine Andes.*—The seventy pages of text in this book are chiefly occupied with descriptive matter referring to the excellent photographs of scenery reproduced in collotype. The author made two journeys from Europe to the La Plata and the mountainous regions of the Argentine, the first time chiefly by way of reconnaissance, and the second with the primary object of fully exploring some of the valleys flanking the mountain mass of Aconcagua. On the second journey the valleys of the Rio de las Bodegas and Rio de las Crevas, and of the Rio de los Horcones were surveyed up to their glaciers, but the work was cut short by the Argentine authorities, who considered further exploration of the mountain inexpedient, pending settlement of boundary disputes with Chili. The narrative contains observations on many points of geographical and geological importance, and gains considerably in interest from the fact that Mr. Vines and the guide Zerbriggen have since ascended Aconcagua from the Horcones valley. A good sketch-map is appended, and some of the panoramic photographs, with the direction angles marked, are of exceptional merit.

POLAR REGIONS.

Mr. Arnold Pike's Cruise in the Arctic Seas.—During the past summer Mr. Arnold Pike and Sir Savile Crossley made an interesting cruise off the east coasts of Spitsbergen and Kong Karls Land. We hope shortly to receive from Mr. Pike a full account of the observations made during the cruise, but meanwhile the following details will be of interest. After steaming through Hinlopen straits and coasting North-East Land as far as Charles XII. island, the voyagers returned through the strait and crossed over to Kong Karls Land. These islands were twice circumnavigated, and a landing effected in several places. An advance was then made for about 40 miles in an east-north-east direction from the east point of Kong Karls Land, no sign being seen, in clear weather, of the land supposed to have been discovered by Captains Johannesen and Andreasen in 1884. Mr. Pike considers that the nature of Kong Karls Land, consisting as it does of high land to the east and west with low land in the centre, may have given rise to the belief that what is really continuous land formed two or even three islands. There is a small island, 8 miles in length, a little north of the east end of Kong Karl, and what seemed to be a lofty island was sighted in an east-north-east direction from the north end of Bremen sound, but, as the weather was thick, the existence of such an island seems

* 'Ausichten aus Südamerika.' Von Jean Habel. Berlin: Dietrich Reimer.

somewhat doubtful. Kong Karls Land was free from snow, and from the well-marked sea-beaches with driftwood, etc., upwards of 100 feet above the present sea-level, Mr. Pike concludes that the land is rising. Many bears were met with on it. Throughout the whole voyage no old pack was seen, and the sea generally was remarkably free from ice. Mr. Pike was informed by the captain of a walrus sloop that the water was much warmer than usual.

Lieut. Peary's Latest Expedition.—Further details respecting Mr. Peary's arctic cruise during the past summer have been telegraphed by the *Times* correspondent at St. John's, Newfoundland. The steam-whaler *Hope*, Captain John Bartlett, with Mr. Peary and various scientific parties on board, left Boston on July 18, and, having put ashore the latter at the spots chosen by them for scientific research, reached Whale sound, Inglefield gulf, on August 10. This point, which the explorer had made his headquarters on previous expeditions, was visited with a view to making arrangements with the Eskimo for the polar expedition planned by Lieut. Peary for next year, details of which have already been given in our pages (vol. ix. p. 223). The explorer puts much stress on the co-operation of the Eskimo, and was able to secure the prospective services of six families, who will be awaiting his arrival next spring. The Cape York meteorite, said to weigh 70 tons, was got on board on the return voyage after incredible efforts, and the *Hope* proceeded homewards, picking up the scientific parties *en route*. The meteorite is to be placed in the Museum of Natural History in New York City.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Seiches and their Cause.—M. Forel contributes to the Académie des Sciences (*Comptes Rendus*, 1897, No. 20) a valuable note containing a careful examination of the relation between sudden changes of barometric pressure and the amplitude of the waves known as seiches. Taking as a specimen a record at the Tour St. Jacques in Paris, of a sudden barometric variation of 6 mm. in a few minutes, Prof. Forel compares this with the amplitude of the highest seiche on record at Geneva—1·87 metres, on October 3, 1841. The comparison is worked out as follows: (*a*) barometric change of 6 mm. represents 82 mm. of water—amplitude of wave 163 mm.; (*b*) these waves are frequently binodal, and may therefore be doubled in amplitude by interference, 326 mm.; (*c*) observation shows that a wave at Chillon may be quadrupled by the time it reaches the observatory at Secheron through the narrowing of the lake, after the manner of a "bore;" (*d*) and at Geneva the amplitude may be half as much again as at Secheron, giving a total of 1·95 metres. Hence an observed change of pressure is more than sufficient to produce the highest observed seiche.

GENERAL.

New Soundings and Deep-sea Temperature Observations.—We have received the Admiralty list of oceanic depths and serial temperature observations for the year 1896. Most of the work has been done by H.M.SS. *Penguin* and *Waterwitch* in the Southern and South-Western Pacific, the former series including the now famous soundings of 5147 fathoms in lat. 28° 44′ S., long. 176° 4′ W., and 5155 fathoms in lat. 30° 28′ S., long. 176° 39′ W., and those in the neighbourhood of Funafuti in connection with the scientific investigations on that island. A few soundings in the Western North Atlantic were made by H.M.S. *Rambler*, H.M.S. *Stork* contributes some from the Mediterranean, and the remainder are from the Indian Marine Survey vessel *Investigator* and three telegraph ships.

Death of the Amazonian Pilot, Captain Manoel Urbano di Monte.—We learn from the *Sketch* for September 22, that the famous pioneer of the

Amazon and its tributaries, Captain Manoel Urbano, died recently at his farm near Manaos, at the junction of the Rio Negro with the Amazon, at an age, it is stated, considerably exceeding a century. Urbano's services to the cause of geography had been no slight ones, as he had served as pilot or guide to most of the chief exploring expeditions into the unknown parts of the Amazon basin, notably that of Chandless for the exploration of the Rio Purus in 1864–1865. He is described as a short, slightly built, dark mulatto, with much of the Indian in his constitution. A portrait given by the *Sketch* shows both the intellectual form of his head and the expression of a gentle, amiable nature. Urbano had constantly endeavoured throughout his life to shield the aboriginal Indians of the Amazon, with whom he mixed freely, from the aggressions of traders and rubber collectors. The story of adventure by Mr. J. W. Wells, entitled 'The Voice of Urbano,' is founded to a large extent on the life-history of the venerable pioneer.

OBITUARY.

E. von Mojsisovics.

The talented geologist and palæontologist, Edmund Mojsisovics, of Mojsvar, died at the end of August last at Feldbach, in Styria, after a prolonged illness caused by brain disease. Born at Vienna on October 18, 1839, his principal claim to recognition as a benefactor to geography lay in the foundation by him, in 1862, of the Austrian Alpine Club, which—largely also through his efforts—was amalgamated with the German Alpine Club in 1873. In 1867 he entered the Imperial College of Geology, and in 1870 became chief geologist and mining expert. In 1891 he was elected an effective member of the Vienna Academy of Sciences, and in 1892 was appointed Vice-director of the Imperial College. He was best known for his palæontological work, the most valuable outcome of which, in addition to minor contributions, was his great work entitled 'Die Cephalopoden der Hallstätter Kalke,' which appeared in two volumes accompanied by an atlas. His services in the field of geographical morphology were, however, by no means inconsiderable. For example, in his work on the dolomites of the Southern Tirol, he confirmed and extended the theory, propounded by Baron von Richthofen nineteen years before, which considered them to be the remains of former coral reefs. Valuable also from a morphological point of view was his demonstration of the constancy of mountain elevations in the Alps; as, again, was the idea—which originated with him—of the division of the Alps into *two* main sections, West and East Alps, separated by the line drawn through the upper Rhine and the Splügen pass, in contra-distinction to the subdivision (morphologically) into *three* parts. In many ways, too, his researches on the phenomena of the "Karst" laid the foundation of our present knowledge. They were in part a result of his scientific work in the mountains of Bosnia and Hercegovina, in the morphological and geological exploration of which he took a large share. Finally, it deserves mention that the zoo-geographical section of the great geographical work set on foot by the late Crown Prince Rudolf, entitled 'Die Osterreichisch-Ungarische Monarchie in Wort und Bild,' was contributed by Mojsisovics. The deceased scientist was in 1896, at his own wish, transferred to Gratz, where he held the post of Professor of Zoology.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By HUGH ROBERT MILL, D.Sc., *Librarian*, R.G.S.

THE following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are in each case written in full:—

A. = Academy, Academie, Akademie.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Com. = Commerce, Commercial.
C. Rd. = Comptes Rendus.
Erdk. = Erdkunde.
G. = Geography, Geographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
J. = Journal.
M. = Mitteilungen.
Mag. = Magazine.
P. = Proceedings.
R. = Royal.
Rev. = Review, Revue, Revista.
S. = Society, Société, Selskab.
Sitzb. = Sitzungsbericht.
T. = Transactions.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is 10 × 6½.

EUROPE.

Alps—Glaciers. *Jahrb. Schweizer Alpenclub* **32** (1897): 282–300. **Forel and Du Pasquier.**
Les variations périodiques des glaciers des Alpes. Par Prof. Dr. F.-A. Forel et Prof. Dr. L. Du Pasquier.

This is the seventeenth report of the Commission for the study of the glaciers of the Alps.

Austria—Istria. *Mém. S. Spéléologie* **1** (3) (1896): 1–20. **Marinitsch.**
La Kačna-Jama (l'Abime des Serpents). Par M. J. Marinitsch. *With Plans.*

Austrian Alps. *M. G. Ges. Wien* **40** (1897): 421–456. **Schönberger.**
Orometrisches aus den Niederen Tauern. Von Franz Schönberger. II. Die Thäler.

This paper includes elaborate statistics of 121 valleys of the Austrian Alps, with reference to their length, elevation at different points, angle of slope, etc.

Austrian Alps. *Deutsche Rundschau G.* **19** (1897): 481–484. **Umlauft.**
Die Bahn auf den Wiener Schneeberg. Von Friedrich Umlauft. *With Illustrations.*

Central Europe—Ice Caves. *Appalachia* **8** (1897): 201–209. **Balch.**
Ice Cave Hunting in Central Europe. By Edwin Swift Balch. *With Illustrations.*

France—Brittany. *J. Anthrop. I.* **27** (1897): 96–103. **Topinard.**
On the Anthropology of Brittany. By Prof. Paul Topinard. Communicated by J. G. Garson, M.D.

France—Corrèze. *Mém. S. Spéléologie* **1** (7) (1897): 1–32. **Lalande.**
Les Grottes artificielles des Environs de Brive (Corrèze). Par M. Philibert Lalande. *With Plans and Illustrations.*

It is suggested that the artificial caves here described and figured were excavated at a very early period by a prehistoric race accustomed to natural cave-dwellings.

France—Côte d'Or. *Mém. S. Spéléologie* **1** (8) (1897): 1–28. **Drioton.**
Les Cavernes de la Côte-d'Or. Par M. Clément Drioton. *With Plans and Illustrations.*

Explorations amongst the caverns of Côte d'Or, with diagrams and photographs.

France—Gard. *Mem. S. Spéléologie* **1** (2) (1896): 1–38. **Mazauric and Cabanès.**
Le Spélunque de Dions (Gard). Par MM. F. Mazauric and G. Cabanès. *With Illustrations.*

The description of the cavern of Dions is accompanied by a list of the flora of that part of the department Gard.

France—Jura. *Mém. S. Spéléologie* **1** (4) (1896): 1-24. **Renauld.**
La Grotte de Baume-les-Messieurs (Jura). Par M. Edmond Renauld. *With Plan and Illustrations.*

France—Jura. *Mém. S. Spéléologie* **1** (6) (1896): 1-36. **Viré.**
La faune souterraine, études sur la Faune Cavernicole du Jura, avec quelques mots sur la faune des Catacombes de Paris et des souterrains refuges de Naours (Somme). Recherches préhistoriques dans le Doubs et le Jura. Par M. Armand Viré. *With Plans and Illustrations.*

France—Lozère. *Mém. S. Spéléologie* **1** (5) (1896): 1-28. **Carrière.**
La Grotte de Dargilan (Lozère). Par M. Gabriel Carrière. *With Plans and Illustrations.*

France—Marseilles. *Mém. S. Spéléologie* **1** (9) (1897): 1-70. **Fournier.**
Les Cavernes des environs de Marseille. Par M. E. Fournier. *With Plans.*
A generalized study of the caverns of the neighbourhood of Marseilles, taking account specially of the fauna discovered in the cave deposits.

France—Mont Blanc. *Alpine J.* **18** (1897): 461-471. **Wilbraham.**
The Narrative of an Ascent of Mont Blanc in 1830. By the Hon. E. Bootle Wilbraham. With an Introductory Note by Douglas W. Freshfield.

France—Padirac. *Mém. S. Spéléologie* **1** (1) (1896): 1-24. **Martel and Rupin.**
Troisième exploration du Gouffre de Padirac (Lot). Par MM. E.-A. Martel and E. Rupin. *With Illustrations.*

France—Vosges—Place-Names. *B S.G. de l'Est* (1896): 356-365. **Fournier.**
Sur la prononciation de quelques noms de lieux dans les Vosges. Par A. Fournier.

Germany. *Globus* **72** (1897): 69-77. **Jansen.**
Die Müggelberge, der Müggelsee und der Teufelssee bei Friedrichshagen in der Mark. Beschreibung, Entstehung, Sagen und Sprachgeschichtliches. Von Dr. Hubert Jansen. *With Maps.*

Germany. *Aus allen Weltteilen* **28** (1897): 537-542, 581-587, 605-614. **Oehlmann.**
Die Herzogtümer Bremen und Verden. Von Dr. E. Oehlmann.

Germany. **Richter.**
Bibliotheca Geographica Germaniæ. Litteratur der Landes- und Volkskunde des Deutschen Reichs bearbeitet im Auftrage der Zentral-Kommission für wissenschaftliche Landeskunde von Deutschland durch Paul Emil Richter. Autoren-Register. Leipzig: W. Engelmann, 1897. Size 9½ × 6, pp. 54.
This is the author's index to the great bibliography of Germany.

Germany—Frisian Islands. **Leichsering.**
Aus allen Weltteilen **28** (1897): 505-514, 549-557.
Zur Rettung der nordfriesischen Insellände. Von Aug. C. Leichsering. *With Illustrations.*

Germany—Prussia. *Globus* **72** (1897): 10-12. **Andrée.**
Das zweiherrige Dorf Woltorf und die preussisch-braunschweigische Grenze bei demselben. Von Richard Andrée. *With Plans.*
The town and district of Woltarf present as curious an instance of complicated political geography as can well be found, both being divided up like irregular chessboards into detached areas subject to the jurisdiction of Prussia, of Brunswick, or of both conjointly.

Holland—Waterways. **Beekman.**
Tijds. K. Ned. Aard. Genoots. Amsterdam (2) **14** (1897): 365-396.
Waterwegen in Oud-Holland. Door A. A. Beekman. *With Map.*
A historical map describing the ancient canals of Holland, with a map of the dykes and canals existing in 1631 between Rotterdam and Amsterdam.

Hungary—Historical. *M.G. Ges. Wien* **40** (1897): 457-524. ——
Die Bevölkerung Ungarns zur Zeit der pragmatischen Sanction.
Extracts from a Hungarian work published on the occasion of the millennium celebration, which deals nominally with the population of Hungary in 1720-1721. The work is really much more extensive, being a general statistical account of the monarchy in the first quarter of the eighteenth century.

Italy—Lago di Fucino. *Globus* **72** (1897): 88-94, 105-110. **Hassert.**
Der Fuciner See einst und jetzt. Von Kurt Hassert. *With Map.*

Mediterranean—Crete. *B.S.G. Lyon* **14** (1897): 375-386. **Chambeyron.**
L'Ile de Crète. Par E. Chambeyron.

Portugal—Wine Industry. ———
Le Vin de Porto à l'Exposition de Bruxelles. 1897. Size 6½ × 9, pp. 32. *Illustrations. Presented by l'Association Commerciale de Porto.*

Russia—Finland. *Acta S. Sci. Fennicæ* **21** (1896): 1-184. **Homén.**
Ueber die Bodentemperatur in Mustiala. Von Theodor Homén.

On ten years' observations of Earth-temperatures in Southern Finland (60° 49' N., 23° 47' E.), made in the open country and in forests. The observations are recorded in full, and are very comprehensively discussed with relation to depth in the soil, seasonal change, the influence of dry and wet summers, and the effect of snow-covering in winter.

Scandinavia. *K. Svensk. Vetens.-A. Handlingar* **28** (1896): 1-210. **Törnebohm.**
Grunddragen af det centrala Skandinaviens bergbyggnad. Af A. E. Törnebohm. *With Maps and Plate.*

Switzerland—Railways. *Rev. Scientifique* (4) **8** (1897): 46-51, 78-81. **Hubon.**
Les chemins de fer suisses. Par M. E. Hubon.

Switzerland—Zermatt. **Whymper.**
The Valley of Zermatt and the Matterhorn. A Guide. By Edward Whymper. London: John Murray, 1897. Size 7½ × 5, pp. xiv. and 212. *Maps and Illustrations. Price* 3*s. Presented by the Author.*

Mr. Whymper has produced a second Alpine Guide-book no less valuable and even more interesting than his guide to Chamonix. Dealing with the Zermatt district, he combines his unsurpassed local knowledge with carefully selected historical matter. The thrilling account of the first ascent of the Matterhorn is reprinted with notes from the author's 'Scrambles amongst the Alps.' There are many excellent illustrations, and a wealth of maps unusual in books of the kind.

United Kingdom—England. *J. Manchester G.S.* **12**, 1896 (1897): 205-236. **Tracy.**
The Manchester Ship Canal: the Story in Brief from 1708 to 1896. By W. Burnett Tracy. *With Map, Plan, and Illustrations.*

United Kingdom—Ireland. *Nineteenth Century* **42** (1897): 185-205. **Mayo.**
The Tourist in Ireland. By the Right Hon. the Earl of Mayo.

A statement of the comfort of modern conditions of travelling in Ireland.

United Kingdom—Tide Tables. **Harris and Goalen.**
Tide Tables for the British and Irish Ports, for the year 1898: also the times and heights of High Water at full and change for the principal places on the Globe. By Captains H. R. Harris and W. N. Goalen. London: J. D. Potter, [1897]. Size 10 × 6, pp. xl. and 262.

United Kingdom—Trade. *Contemporary Rev.* **72** (1897): 333-340. **Mulhall.**
Our Trade with Germany and Belgium. By Michael G Mulhall.

ASIA.

Afghanistan—Káfiristan. *J. Anthrop I.* **27** (1897): 75-89. **Robertson.**
Káfiristan and its People. By Sir George Scott Robertson, K.C.S.I. *With Plates.*

Asia. **Cahun.**
Introduction à l'Histoire de l'Asie, Turcs et Mongols des Origines à 1405. Par Léon Cahun. Paris: A. Colin & Cie., 1896. Size 9½ × 6½, pp. xiv. and 520. *Presented by the Executors of the late Mr. Ney Elias.*

After a short geographical chapter, M. Cahun discusses successively the earliest inhabitants of Asia, the Turks and Islam, the Mongols, Asia under the Mongols, and concludes with an account of Timour and the triumph of Islam. The book deals with the period which elapsed between the fall of the Persian civilization in Asia and the rise of the great power of China.

Asia Minor. *P.R. Artillery I.* **24** (1897): 427-443. **Clayton.**
Consular experiences in Turkey. By Colonel E. Clayton. *With Map.*

Describes a journey from Erzerum to Van and through Armenia, with references to the condition of Asiatic Turkey.

China. *B.S.G. Commerc. Paris* **19** (1897): 477–511. **Dujardin-Beaumetz.**

Le commerce de la Chine avec l'Étranger. Par M. F. Dujardin-Beaumetz.

China.

China. Imperial Maritime Customs. 1.—Statistical Series: Nos. 3 and 4. Returns of Trade and Trade Reports for the year 1896. Part i.—Report on the Trade of China, and Abstract of Statistics. Shanghai: Kelly & Walsh, 1897. Size 11 × 9, pp. 32.

China. *B.S.G. Paris* (7) **18** (1897): 36–80. **Soulié.**

De Ta-tsien-loû à Tse-kou (rive droite du Mékong). 11 octobre—7 décembre 1894. Nouvelle route à travers le pays de Ly-thang et de Bathing, passage du Yalong-Kiang, du Fleuve Bleu et du Mékong. Par le R. P. J. Soulié. *With Map.*

China and Japan. *B.S.G. Lyon* **14** (1897): 293–308. **Pila.**

Le développement économique de la Chine et du Japon. Par M. Ulysse Pila.

China—Western Provinces. **Hosie.**

Three Years in Western China: a Narrative of Three Journeys in Ssŭ-ch'uan, Kuei-chow, and Yün-nan. By Alexander Hosie. Second Edition. London: G. Philip & Son, 1897. Size 9 × 6, pp. xxviii. and 302. *Map and Frontispiece. Price* 6*s. Presented by the Publishers.*

Mr. Hosie's excellent book on Western China will be welcomed in this cheaper edition, as it is a work of permanent value and popular interest. A preface gives a concise history of the changes in the Chinese commercial policy on the upper Yang-tze since 1889, when the book was written, and bears testimony to the vast importance of Sze-chuan and Yunnan as producing areas. The development of the opium-manufacture from native poppies is particularly striking.

China—Western Sze-chuan. **Bishop.**

A Journey in Western Sze-chuan. By Mrs. Isabella Bishop. From the *Geographical Journal* for July, 1897. Size 10 × 6½, pp. 32. *Map and Illustrations.*

China—Yunnan. **Rouvier.**

Rev. G. **39** (1896): 19, 110, 192, 267, 409; **40** (1897): 23, 81, 433; **41** (1897): 26.

La province chinoise du Yunnan et les routes qui y mènent. Par G. Rouvier. *With Maps.*

A careful study of the province of Yunnan and the routes of approach.

Dutch East Indies. **Heeres and Van Riemsdijk.**

Dagh-Register gehouden int Casteel Batavia vant passerende daer ter plaetse als over geheel Nederlandts-India. Anno 1624–1629. Uitgegeven door het Departement van Koloniën onder toezicht van Mr. J. E. Heeres. Met een Inleiding van Jhr. Mr. Th. van Riemsdijk. 's-Gravenhage: M. Nijhoff, 1896. Size 11 × 7½, pp. viii. and 418.

French Indo-China. *J. Asiatique* **9** (1897): 185–222. **Aymonier.**

Le Cambodge et ses monuments. La province de Ba Phnom. Par M. Étienne Aymonier.

India. *J. East India A.* **29** (1897): 17–48. **Sewell.**

India before the English. By R. Sewell.

Historical retrospects designed to bring out the actual condition of India before British supremacy was established.

India—Baluchistan. *Scottish G. Mag.* **13** (1897): 357–366. **Yate.**

Loralai. By Major A. C. Yate.

India—Caste. *Z. Deutschen Morgenländ. Ges.* **51** (1897): 267–290. **Oldenberg.**

Zur Geschichte des indischen Kastenwesens. Von Hermann Oldenberg.

A history of the caste customs in India.

India—Frontier Tribes. *J. Anthrop. I.* **26** (1896): 161–201; **27** (1897): 2–51. **Godden.**

Nágá and other Frontier Tribes of North-East India. By Gertrude M. Godden. *With Plates.*

India—Survey Report.

General Report on the Operations of the Survey of India Department administered under the Government of India during 1895-96. Prepared under the direction of Major-General C. Strahan, R.E., Surveyor-General of India. Calcutta, 1897. Size 13 × 8½, pp. 110 and L. *Maps and Plates. Presented by the Surveyor-General of India.*

Indo-China. *B.S.G. Paris* **18** (1897): 81–95. **Roux.**

Renseignements géographiques inédits recueillis, en dehors de l'itinéraire suivi, au cours de l'expédition du Prince Henri d'Orléans, de MM. E. Roux et Briffant du Tonkin aux Indes (Janvier 1895—Janvier 1895). Par Émile Roux.

Japan. **Ehmann.**

Sprichwörter und bildliche Ausdrücke der Japanischen Sprache. Gesammelt übersetzt und erklärt von P. Ehmann. Theil i (von A bis G). Supplement der *Mittheilungen* der Deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens. Tokyo, 1897. Size 9 × 6, pp. xxii. and 48.

Japan—Formosa. **Riess.**

M. Deutsch. Ges. Natur- u. Völkerkunde Ostasiens, Tokio **59** Heft (1897): 405–447.

Geschichte der Insel Formosa. Von Ludwig Riess. *With Maps.*

Japan—Kamegaoka. *J. Tōkyō G.S.* **19** (1896): 169–216. **Satō.**

Kamegaoka in the Province of Mutsu: its Physical and Geological Features; and Relics of the Stone Age. By D. Satō, Rigakushi. [In Japanese.]

Japan—Luchuan Bibliography. *Trans. Asiatic S. Japan* **24** (1896): 1–11. **Chamberlain.**

Contributions to a Bibliography of Luchu. By Basil Hall Chamberlain.

Japan—Musashi. *J. Tōkyō G.S.* **18** (1896): 385–444. **Yagi.**

The Topographical Distribution of Dolmens in Musashi. By S. Yagi. [In Japanese.]

Malay Archipelago—Amboyna. **Heeres.**

Bijd. Taal-, Land- en Volkenk. Ned.-Indië (6) **3** (1897): 510–595.

Ambon in 1647. Door J. E. Heeres.

Reprint, with introductory remarks, of a memoir written in 1647 by the outgoing Governor, Gerard Demmer, for the use of his successor, Arnold de Vlamingh.

Malay Archipelago—Borneo. **Barth.**

Overzicht der Afdeeling Soekadana. Door J. P. J. Barth. Verhandelingen von het Bataviaasch Genootschap van Kunsten en Wetenschappen. Deel L. 2e Stuk. Batavia: Albrecht & Co., 1896. Size 11½ × 8, pp. 146. *Plates.*

This work contains a sketch of the Dutch relations with Soekadana since 1824, followed by a detailed description, mainly from personal knowledge, of the separate districts which make up the division.

Malay Archipelago—Krakatau. **Muller.**

Tijds. K. Ned. Aardrijks. Genoots. Amsterdam (2) **14** (1897): 118–122.

De eilanden Krakatau en Langeiland. Door J. J. A. Muller.

Short account of a visit of the Dutch government surveyors to Krakatau, in June, 1896. The thick layer of volcanic ashes which entirely covered the island at the eruption in 1883, is now cut into deep ravines by the action of rain, making it almost impossible to traverse the island.

Malay Archipelago—Philippine Islands. **Virchow.**

Sitz. K.P.A. Wiss. Berlin (1897): 279–289.

Die Bevölkerung der Philippinen. Von Rud. Virchow.

On the type of the people—not on the population—of the Philippine Islands.

Malay Archipelago—Sumatra. **Heyting.**

Tijds. K. Ned. Aard. Genoots. Amsterdam (2) **14** (1897): 209–320.

Beschrijving der Onderafdeeling Groot-Mandeling en Batang-Natal. Door Th. A. L. Heyting. *With Map.*

Malay Archipelago—Sumatra. **Haan.**

Tijds. Indische Taal-, Land- en Volkenk. **39** (1896): 327–366.

Naar Midden-Sumatra in 1684. Door Dr. F. de Haan.

Malay Archipelago—Sumatra. **Westenberg.**

Tijds. K. Ned. Aardrijks. Genoots. Amsterdam (2) **14** (1897): 1–112.

Verslag eener reis naar de Onafhankelijke Bataklanden ten Noorden van het Tobameer. Door C. J. Westenberg. *With Map.*

Malay Peninsula. *J. Asiatic S. Bengal* **65** (Pt. 2) (1896): 339–516. **King.**

Materials for a Flora of the Malayan Peninsula. No. 8. By George King, M.B., etc.

Philippine Islands. *B.S.G. Madrid* **39** (1897): 47–48. ——

Comunicaciones telegráficas submarinas en Filipinas.

AFRICA.

Abyssinia. *B.S. Khédiv. G.* 4 S. (1897): 701–722. **Macaire.**
Mon Voyage en Abyssinie. Par S. G. Msg. Kyrillos Macaire.

Abyssinia. *Rev. G.* **41** (1897): 101–108. **Rouire.**
L'Éthiopie. La paix d'Addis-Ababa—La Question des Frontières Éthiopiennes. L'Avenir de l'Éthiopie. Par le Dr. Rouire.

British South Africa. *Contemporary Rev.* **72** (1897): 470–481. **Holland.**
The Prospects of Rhodesia. By F. Catesby Holland.

Cape Colony. **Johns.**
The Coalfields of the Colony of the Cape of Good Hope. By Percy Johns (Kimberley). Cape Town, 1897. Size 9½ × 7½, pp. 16.

Congo State—Lake Leopold II. *Mouvement G.* **14** (1897): 337–340. ———
Le lac Léopold II. *With Map.*

Egypt—Antinoë. *A travers le Monde* (*Tour du Monde*) **3** (1897): 225–228. **Gayet.**
La Découverte du Temple de Ramsès II. à Antinoë. Par M. Albert Gayet. *With Illustrations.*

Egypt—Dongola and Nubia. *B.S. Khédiv. G.* 4 S. (1897): 745–765. **Abbate.**
Dongola et la Nubie. Par le Dr. O. Abbate Pacha.

Egypt—Flint Mines. *J. Anthrop. I.* **27** (1897): 90–92. **Seton-Karr.**
Discovery of the Lost Flint Mines of Egypt. By H. W. Seton-Karr.

Egypt—Winter Climate. *Quarterly J. R. Meteorolog. S.* **23** (1897): 154–198. **Canney.**
The Winter Climate of Egypt. By H. E. Leigh Canney, M.D. *With Diagrams.*

Egyptians. **Schweinfurth.**
Dr. G. Schweinfurth. De l'Origine des Égyptiens et sur quelques-uns de leurs usages remontant à l'age de la pierre. Extrait du Bulletin de la Société Khédiviale de Géographie, IV^e^ série, No. 12. Le Caire, 1897. Size 9½ × 6½, pp. 24.

Lagos. *P.R. Colonial I.* **28** (1896-97): 275–304. **Carter.**
The Colony of Lagos. By Sir Gilbert T. Carter, K.C.M.G.

Madagascar. *Rev. Française* **22** (1897): 325–342. **Duponchel.**
Madagascar: Un projet de chemin de fer. Par A. Duponchel. *With Map.*
Description of a projected railway from Mahanoro on the east coast to Antananarino.

Madagascar. *B.S.G. Paris* (7) **18** (1897): 96–105. **Grandidier.**
Voyage de M. Lemaire dans l'Androy (Octobre 1896). Résumé par M. Alfred Grandidier. *With Map.*

Madagascar. *Ann. G.* **6** (1897): 368–369. ———
L'organisation militaire et administrative de Madagascar. *With Map.*

Madagascar. *Mem. S.G. Italiana* **6** (1897): 193–198. **Marinelli.**
Media altezza dell' Isola di Madagascar. Nota del socio Prof. Olinto Marinelli.
Calculations from the orographical map in the *Annales de Géographie* give 602 metres, or 1975 feet, as the average elevation of Madagascar.

Madagascar. *J.R. United Service I.* **41** (1897): 722–767. **Oliver.**
The Madagascar Expedition of 1895-96. Summarized from the Official Report of General Duchesne. By Captain S. Pasfield Oliver. *With Map.*

Madagascar and Réunion. **Oliver.**
The Voyages made by the Sieur D. B. to the Islands Dauphine or Madagascar and Bourbon or Mascarenne in the years 1669–70–71, and 1672. Translated and Edited by Captain Pasfield Oliver. With Facsimile Maps and Illustrations. [Supplement to the Voyage of François Leguat, issued by The Hakluyt Society, Nos. lxxxii. and lxxxiii., 1891.] London: David Nutt, 1897. Size 9½ × 6, pp. xxxvi. and 160. *Price* 10*s.* 6*d.* *Presented by the Publisher.*
The original of this journal, which is now first published in English, was printed in Paris in 1674 in duodecimo form. The author, whose name, as appears from his dedicatory letter, was Dubois, went to Madagascar at the time of the early French connection with the island, apparently to find official employment at Fort Dauphin. The chief interest in his account centres in his description of the fauna of Réunion (Mascarenne as he calls it), including the dodo and the gigantic tortoises of the island. The

present edition contains, in addition to the Editor's notes, appendices by well-known zoologists on points with reference to the fauna needing elucidation. The greater number of the illustrations are from the photographs of Dr. Catat.

Madagascar—Railways. Duponchel.

Rev. Scientifique (4) **7** (1897): 622–625, 774–780.

Les chemins de fer de Madagascar. Par M. A. Duponchel.

Morocco. *Rev. G.* **40** (1897): 409–415; **41** (1897): 8–14. Rouire.

Le Maroc. Positions respectives des puissances Européennes dans la question Marocaine, le Traité Franco-Marocain de 1845, l'avenir du Maroc. Par le Dr. Rouire.

Morocco—Fez. Macpherson.

Medical Report on the Mission of Sir G. Euan-Smith to Fez in 1892, with one plan. By Surgeon-Captain W. G. Macpherson. Army Medical Department. Report for the year 1892, with Appendix. Vol. xxxiv. London: Eyre & Spottiswoode, 1894. Size 10 × 6½, pp. 314–379.

This report contains valuable geographical observations on the journey to Fez and on that city.

North Africa—Anthropological. Sergi.

Giuseppe Sergi. Africa. Antropologia della Stirpe Camitica (Specie Eurafricana). Torino: Fratelli Bocca, 1897. Size 9½ × 6½, pp. xvi. and 426. *Maps and Illustrations. Presented by the Publishers.*

A treatise on the anthropology of the Hamitic races of Africa, which will be farther referred to along with other recent books on Africa.

North-West Africa. *B.S.G. et d'Archéologie d'Oran* **17** (1897): 243–252. Bernard.

Documents pour servir à l'étude du Nord-Ouest Africain. Par Augustin Bernard.

A short account of a collection of documents relating to Morocco, many derived from native sources, made by order of the Governor-General of Algeria.

North-West Africa. *Ann. G.* **6** (1897): 357–363. De la Blache.

La zone frontière de l'Algérie et du Maroc d'après de nouveaux documents. Par M. P. Vidal de la Blache.

A review of the above-mentioned collection of documents.

Nubian Desert. *Quarterly J. Geolog. S.* **53** (1897): 360–376. Lyons, Raisin, Aston.

Note on a Portion of the Nubian Desert south-east of Korosko. I. Field Geology. By Capt. H. G. Lyons. II. Petrology. By Miss C. A. Raisin, B.Sc. III. Water Analyses. By Miss E. Aston, B.Sc. *With Map.*

Somaliland—Stone Implements. *J. Anthrop. I.* **27** (1897): 93–95. Seton-Karr.

Further Discoveries of Ancient Stone Implements in Somaliland. By H. W. Seton-Karr. *With Plates.*

South Africa. Schlichter.

Neues über Karl Mauchs Forschungen in Südostafrika. Von Dr. H. G. Schlichter. (Sonderabdruck aus dem Jahresbericht, 1896, des Württ. Vereins für Handelsgeographie, pp. 98–133.) Size 10 × 7. *Portrait. Presented by the Author.*

South Africa and Madagascar. *B.S.G. Lyon* **14** (1897): 319–374. Gindre.

En Afrique australe et à Madagascar. Par M. Henri Gindre.

South Africa. *P.R. Artillery I.* **24** (1897): 277–299. Levita.

A Visit to South Africa. By Lieut. C. B. Levita. *With Map.*

Notes of an extempore lecture describing a tour in South Africa, including the Transvaal and Rhodesia.

NORTH AMERICA.

Canada. *Trans. G.S. Quebec*, 1893–97 (1897): 101–143. O'Sullivan.

Lecture on Northern Canada. By H. O'Sullivan. *With Maps.*

This paper outlines a scheme for a transcontinental railway from Quebec to James bay, and thence westward in a straight line to the Pacific coast, passing north of Lake Winnipeg.

Canada—Anticosti. *Trans. G.S. Quebec*, 1893–97 (1897): 174–210. Le Vasseur.

Anticosti, esquisse historique et géographique. Par M. N. Le Vasseur.

Canada—Hudson Bay Region. **Bell.**

Recent Explorations to the South of Hudson Bay. By Dr. Robert Bell, F.R.S. From the *Geographical Journal* for July, 1897. Size 10 × 6½, pp. 20. *Map and Illustrations.*

Canada—New Brunswick, Place-Names. **Ganong.**

A Monograph of the Place-nomenclature of the Province of New Brunswick. (Contributions to the History of New Brunswick, No. 2.) By William F. Ganong, M.A., PH.D. [From the *Translations of the Royal Society of Canada*, Second Series, 1896–97. Volume ii. Section ii. English Literature, History, Archæology, etc.] Ottawa: John Durie & Son, 1896. Size 10 × 7, pp. 175–290. *Presented by the Author.*

Canada—North-West Territory. *Contemporary Rev.* **72** (1897): 305–311. **De Windt.**

The Klondike Goldfields. By Harry De Windt. *With Map.*

Canada—Tides and Currents. **Dawson.**

Survey of Tides and Currents in Canadian Waters. Report of Progress by W. Bell Dawson, C.E. Ottawa, 1897. Size 10 × 7, pp. 50. *Charts and Diagrams.*

Mr. Dawson's valuable work on the tides of the Gulf of St. Lawrence has already been referred to in the *Journal*. The present report shows that important records were obtained last year. Apart from the scientific bearings of the investigation, we hope that the practical importance with regard to the proposed fast line of steamers to the St. Lawrence will induce the Dominion Government to continue the work.

Mexican Islands. *B S.G. y Estadistica Rep. Mexicana* (4) **3** (1894): 168–206. ———

Dictamen de la Comisión respectiva acerca de los derechos de México sobre el Archipiélago del Norte, situado frente á las costas de la Alta California. *With Map and Chart.*

Mexico—Mountains. *Alpine J.* **18** (1897): 456–461. **Hamilton.**

Ascents in Mexico. By A. R. Hamilton.

CENTRAL AND SOUTH AMERICA.

Argentine Republic—Buenos Ayres. ———

Bureau Général de Statistique de la Province de Buenos Aires. L'Agriculture, l'Élevage, l'Industrie et le Commerce dans la Province en 1895. Mémoire publié sous la direction de Carlos P. Salas. La Plata, 1897. Size 11½ × 8, pp. cx. and 102. *Maps. Presented by Carlos P. Salas, Directeur-Général de la Statistique.*

Bolivia. **Muñoz.**

Ministerio de Instrucción Pública y Fomento. Informe del Jefe de la Mesa Topográfica de la Delegacion Nacional en el N.O. presentado al Señor Ministro de Instrucción Pública y Fomento sobre exploraciones efectuadas en el Norte de la República. Sucre, 1897. Size 12 × 8½, pp. 40. *Map. Presented by M. V. Ballivian.*

Bolivia and Peru. ———

Oficina Nacional de Inmigración, Estadistica y Propoganda Geográfica. Cuestion de Limites entre Bolivia y el Peru. Sobre la region de Caupolican ó Apolobamba. La Paz, 1897. Size 9 × 6, pp. iv. and 264. *Presented by the Author.*

A discussion, from the Bolivian side, of the disputed boundaries between Bolivia and Peru.

AUSTRALASIA AND PACIFIC ISLANDS.

Australia. *B.S. Khédiv. G.* **4** (1897): 723–744. **Bircher.**

L'Australie. Par Henri Bircher.

British New Guinea. **Macgregor.**

British New Guinea: Country and People. By Sir William Macgregor, K.C.M.G. London: John Murray, 1897. Size 8½ × 5½, pp. 100. *Map and Illustrations.*

This important work includes the paper read by Sir Wm. Macgregor at the Royal Geographical Society. It is the most complete and authoritative treatise on British New Guinea ever compiled.

Hawaii. *Rev. Française* **22** (1897): 385–396. **Servigny**

Hawai et les États-Unis. Par J. Servigny.

A general sketch of the Sandwich islands, historical and actual.

New Guinea. *B.S.G. de l'Est* (1896): 366-380. **Lemoine.**

Exploration en Papouasie. Par J.-A. Lemoine. *With Map.*

New Zealand—Census.

Results of a Census of the Colony of New Zealand, taken for the night of the 12th April, 1896. Wellington, 1897. Size 13½ × 8½, pp. vi., 368, and lxvi.

The population of New Zealand in 1896 was 743,214, of whom 39,834 were Maoris. The total population of the chef towns, including their suburbs, was—Auckland, 57,616; Wellington, 41,758; Christchurch, 51,330: and Dunedin, 47,280.

New Zealand—Deep-Sea Fauna. **Hamilton.**

New Zealand Institute. Deep-Sea Fauna of New Zealand. Extracted from the 'Reports of the *Challenger* Expedition.' By A. Hamilton. Wellington, 1896. Size 10 × 6, pp. 30. *Chart.*

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Coast-line. *B. Geolog. S. America* 7 (1896): 399-422. **Gulliver.**

Cuspate Forelands. By F. P. Gulliver. *With Illustrations.*

Land-surface. *B. Geolog. S. America* 7 (1896): 377-398. **Davis.**

Plains of Marine and Subaërial Denudation. By W. M. Davis.

Oceanography. *Natural Science* 11 (1897): 48-49. **Smith.**

Note on the Warm Undercurrent in the Arctic Ocean between Greenland and Spitzbergen. By B. Leigh Smith.

Oceanography. *B.S.G. Paris* 18 (1897): 5-35. **Thoulet.**

Cartes lithologiques sous-marines. Par M. J. Thoulet.

Oceanography—Adriatic. *Riv. G. Italiana* 4 (1897): 266-281. **Gavazzi.**

La temperatura della superficie del Mare Adriatico. Appunti del Prof. Dott. Arturo Gavazzi.

Oceanography—Marine Life. *Natural Science* 11 (1897): 17-27. **Murray**

On the Distribution of the Pelagic Foraminifera at the Surface and on the Floor of the Ocean. By John Murray, LL.D., F.R.S. *With Illustrations.*

The author terms the limit of saturation the "surface of the sub-lake," and describes observations on wells which confirm the relation of underground water to rainfall as elaborated by the long series of observations in Europe.

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Cabot. *Globus* 72 (1897): 1-3. **Ruge.**

Die Entdeckung Nordamerikas durch Giovanni Caboto im Sommer 1497. Von Sophus Ruge.

Cabot. *Rev. G.* 40 (1897): 401-408; 41 (1897): 36-43. **Harrisse.**

Sébastien Cabot, pilote major d'Espagne, considéré comme Cartographe. Par H. Harrisse.

Cabot's Voyage. **Harrisse.**

The Discovery of North America by John Cabot, the alleged Date and Landfall, also the ship's name, the *Matthew*, a forgery of Chatterton? By Henry Harrisse. Third Edition. London: B. F. Stevens, 1897. Size 8 × 5½, pp. 48. *Presented by the Publisher.*

Mr. Harrisse advances reasons for his belief that the data available for the discussion of Cabot's voyage are not sufficient to justify any conclusion as to the place or date of the landfall, and the name of the ship, the *Matthew*, he imputes to a forgery of Chatterton's.

Dutch Voyage. **Groeneveldt.**

Tijds. K. Ned. Aard. Genoots. Amsterdam 14 (1897): 397-410.

Eene Reis van eene Nederlandsche Vloot in het begin der 17 de eeuw. Door W. P. Groeneveldt.

Account of the voyage of a Dutch fleet from Java to the Chinese coast in 1622.

Geographic Environment. *National G. Mag.* 8 (1897): 161-176. **Hubbard.**

The Effects of Geographic Environment in the Development of Civilization in Primitive Man. By Gardiner G. Hubbard.

Historical Routes. **De la Blache.**
Les voies de commerce dans la Géographie de Ptolémée. Par M. Vidal de la Blache. Extrait des Comptes Rendus de l'Académie des Inscriptions et Belles-Lettres. Séance du 6 Novembre 1896. Paris: Imp. Nationale, 1896. Size 9 × 6, pp. 32. *Maps. Presented by the Author.*

An endeavour to elucidate Ptolemy's Geographical Tables by reference to the trade routes in use during the second century, showing what were the probable data thus available for Ptolemy, and what use he made of them.

Historical—Vespucci. *Mem. S.G. Italiana* **6** (1897): 209–226. **Martino.**
Sulla relazione di Amerigo Vespucci al Gonfaloniere Pier Soderini, studio del dott. Antonio de Martino.

Italian Emigration. *Ann. G.* **6** (1897): 123–132. **Yver.**
L'émigration italienne. Par M. G. Yver.

A study of the destination and origin of the migrating Italians, nearly 300,000 of whom leave Italy annually.

Pygmy Tribes. *P. Canadian I.* **1** (1897): 3–7. **Haliburton.**
The Dwarf Domestic Animals of Pygmies. By R. G. Haliburton.

BIOGRAPHY.

Dickson. *Deutsche Rundschau G.* **19** (1897): 520–521. **Wolkenhauer.**
Oskar Dickson. Von W. Wolkenhauer. *With Portrait.*

Flammarion. *Deutsche Rundschau G.* **19** (1897): 421–422. ——
Camille Flammarion. *With Portrait.*

Goode. **Langley.**
Memoir of George Brown Goode, 1851–1896. By S. P. Langley. Read before the National Academy, April 21, 1897. Washington, 1897. Size 10 × 6½, pp. 30.

Haardt. *Deutsche Rundschau G.* **19** (1897): 518–519. ——
Vincenz v. Haardt. *With Portrait.*

Melville. *National G. Mag.* **8** (1897): 187–190. ——
George W. Melville, Engineer-in-Chief, U.S. Navy. *With Portrait.*

Newton. **Gibbs.**
Hubert Anson Newton. By J. Wittard Gibbs. [From the *American Journal of Science*, vol. iii., May, 1897.] Size 9½ × 6, pp. 20. *Portrait. Presented by the Author.*

Mr. Newton's work as an astronomer was concerned mainly with meteors.

Simler. *Jahrb. Schweizer Alpin Club* **32** (1897): 217–234. **Knonan.**
Josias Simler als Verfasser der "Vallesiæ Descriptio" und des "Commentarius de Alpibus." Von G. Meyer von Knonau.

Josias Simler, born in 1530 in Zurich, wrote a description of Valais and of the Alps, of which a summary is given in this article.

Stephan. *Deutsche Rundschau G.* **19** (1897): 422–424. ——
Der deutsche Generalpostmeister Dr. Heinrich v. Stephan. *With Portrait.*

Wilson-Barker. *Nautical Mag.* **66** (1897): 567–569. ——
The Editor's Album. Captain David Wilson-Barker, Lieut. R.N.R. *With Portrait.*

GENERAL.

Bibliography. **Chilovi.**
I Cataloghi e l'Istituto Internazionale di Bibliografia. Osservazioni di D. Chilovi. I. I Cataloghi delle Biblioteche. Firenze: Fratelli Bocca, 1897. Size 11 × 7½, pp. 42.

Bibliography—Royal Colonial Institute. ——
P.R. Colonial I. **28** (1896–97): 484–494.

Index to the Papers and Authors in Volumes I. to XXVIII. of the *Proceedings of the Royal Colonial Institute.*

Bibliography. **Sonnenschein.**
A Bibliography of Geography, being the sections relating to that subject in 'The Best Books' and 'The Reader's Guide.' By William Swan Sonnenschein.

London: Sonnenschein & Co., 1897. Size 10½ × 8½, pp. [138]. *Price 4s. 6d. Presented by the Publishers.*

This is a reprint of the bibliography of Geography published in 'The Best Books' some years ago, with an appendix containing additions up to 1894.

Bibliography. **Thoulet.**

Notice sur les travaux scientifiques publiés, par M. J. Thoulet. Nancy, 1897. Size 10 × 6½, pp. 64. *Presented by the Author.*

Prof. Thoulet gives a chronological list of 140 memoirs, of which he is the author, ranging from 1868 to the present year. They deal with many questions of mathematical and physical geography, latterly largely with oceanography. Most of the titles are followed by a summary of the contents of the papers referred to.

Commercial Geography. *Contemporary Rev.* **72** (1897): 213–218. **Mulhall.**

Twenty Years of Trade. By Michael G. Mulhall.

Contrast of the trade of the world in 1876 and 1896.

Commercial Geography. *Scottish G. Mag.* **13** (1897): 337–357. **Tyler.**

The Geography of Communications. By Sir Henry Tyler.

Educational—Methods. **Davis.**

Studies for Students. Large Scale Maps as Geographical Illustrations. By W. M. Davis. (Reprinted from the *Journal of Geology*, vol. iv. No. 4, May—June, 1896). Chicago, 1896. Size 9½ × 7, pp. [30].

Egyptian Writing. ———

An Egyptian Alphabet for the Egyptian People. Florence: The Landi Press, 1315–1897. Size 10 × 7, pp. 56.

This anonymous pamphlet proposes a transliteration of the Arabic alphabet for the use of Egyptians. The form adopted is a Roman alphabet with a few diacritical marks. Its use is illustrated by a number of examples.

Geography in 1895. **Campos.**

La Geografía en 1895. Memoria sobre el VI. Congreso Internacional de Ciencias geográficas celebrado en Lóndres. Por Rafael Torres Campos. Madrid, 1897. Size 9½ × 6½, pp. 288. *Plates. Presented by the Author.*

Señor Torres Campos has, in his lengthy report on the Sixth International Geographical Congress, given a very full account of the work of the London meeting, with original notes, and in some instances bibliographies of some length bearing on the subject of the Congress papers.

German Colonies. **Barré.**

B.S.G. Marseille **20** (1896): 225–243, 396–413: **21** (1897): 25–40.

Notes sur l'Empire colonial de l'Allemagne. Par M. Henri Barré.

German Colonies. *Kolon. Jahrb.* **10** (1897): 18–39. **Pfeil.**

Ein Beitrag zur Frage der Verbrecherdeportation nach deutschen Kolonien. Von Joachim Graf Pfeil.

Lima Geographical Society. **Carranza.**

Memoria que el presidente de la Sociedad Geográfica de Lima Dr. D. Luis Carranza presenta a la junta general de la Sociedad en su ultima sesion de año (1897). Lima, 1897. Size 10½ × 7, pp. 24. *Presented by the Author.*

The annual address to the Lima Geographical Society, summarizing the geographical activity of Peru.

Missionary Reports. ———

Free Church of Scotland. Missionary Reports (Foreign), May, 1897. 1. Foreign Missions (including Report of Woman's Society). 2. Colonial Missions. 3. Continental Missions. 4. Missions to the Jews. Edinburgh, 1897. Size 9 × 5½, pp. 128, 78, 20, 16, and 20.

Monetary Systems. *Deutsche G. Blätter* **20** (1897): 1–66. **Shurtz.**

Beiträge zur Entstehungsgeschichte des Geldes. Von H. Schurtz.

Notes on the history of the origin of monetary systems in different parts of the world.

Mountain Observatories. **Holden.**

Smithsonian Miscellaneous Collections. 1035. Mountain Observatories in America and Europe. By Edward S. Holden. Washington: The Smithsonian Institution, 1896. Size 9½ × 6, pp. vi. and 78. *Plates. Presented by the Smithsonian Institution.*

A study of the conditions for meteorological observations at high altitudes in Europe

and America. There are excellent photographs of all the mountain astronomical observatories referred to.

Mountaineering—Historical. **Zschokke.**

Jahrb. Schweizer Alpenclub **32** (1897): 203-216.

Zur Geschichte des Bergsteigens. Pilatusberg und Mont Ventoux. Von Dr. A. Zschokke.

Notes on early references to the beauty of scenery or mountain-climbing.

NEW MAPS.

By J. COLES, *Map Curator*, R.G.S.

EUROPE.

Denmark. **Danish General Staff.**

Generalstabens topografiske Kaart over Denmark. Scale 1: 40,000 or 1·5 inch to a stat. mile. Kalkograferet og graveret ved Generalstaben Kjobenhavn 1896. Sheets—Jannerup, Nibe, Öland. *Presented by the Danish General Staff, through H.E. the Danish Minister.*

England and Wales. **Ordnance Survey.**

Publications issued between August 8 and September 8, 1897.

1-inch—General Maps:—

ENGLAND AND WALES:—108, 122, 167, hills photozincographed in brown; 1, 2, 3, 7, 10, 11, 12, 15, 16, 22, 47, 111, 112, 124, 125, 233, 259, 337, 343, engraved in outline; 256, 270, hills engraved in black. 1*s.* each.

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ENGLAND AND WALES:—**Hampshire** (revised), 4 S.E., 5 S.E., 7 S.E., 8 N.W., 10 S.W., 12 N.E., 16 S.E., 19 S.E., 20 S.W., 22 S.W., S.E., 24 S.E., 31 S.W., S.E., 32 N.W., S.W., 33 N.W., 34 N.W., S.W., S.E., 35 N.W., N.E., S.W., 36 N.W., S.W., 39 N.W., N.E., S.W., S.E., 40 N.E., S.E., 41 N.W., N.E., S.E., 42 N.E., S.W., S.E., 43 N.W., N.E., S.W. **Kent,** 12 N.E. **Middlesex,** 1 S.E., 10 N.W., 15 N.W., 11 N.W. **Surrey,** 18 S.E. 1*s.* each.

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Karte des Deutschen Reiches. Herausgegeben von der Kartogr. Abtheilung der Königl. Preuss. Landes-Aufnahme, 1894. Sheets: 379, Elberfield; 429, Düren, 480, Malmedy. Scale 1: 100,000 or 1·7 stat. mile to an inch. *Price* 1·50 *marks* each sheet.

Historical Geography. **Poole.**

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North-West Frontier of India. **Bartholomew.**

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(*E. Stanford, Agent.*)

North-West Frontier of India. **Stanford.**

Stanford's Sketch-Map of the North-Western Frontier of India. Scale 1 : 633,600 or 10 stat. miles to an inch. By E. Stanford. Stanford's Geographical Establishment. London, 1897. *Presented by the Publisher.*

AFRICA.

Central Africa. **Hassenstein.**

Neue Reiserouten in Marangu und Itawa 1891 bis 1895. Mit Benutzung einer Originalskizze des S. G. Mscr. Roelens, Priester de Mission d'Afrique des Pères Blanches, gezeichnet von Dr. B. Hassenstein. Scale 1 : 750,000 or 11·9 stat. miles to an inch. *Petermanns Geographische Mitteilungen*, Jahrgang 1897, Tafel 14. Gotha: Justus Perthes, 1897. *Presented by the Publisher.*

German East Africa. **Kiepert and Moisel.**

Karte von Deutsch-Ostafrika. Scale 1 : 300,000 or 4·7 stat. miles to an inch. Sheet C 5, Massai-Steppe. Berlin: Geographische Verlagshandlung Dietrich Reimer (Ernst Vohsen).

AMERICA.

British Columbia. **Fletcher.**

Map of the East and West Kootenay District. Scale 1 : 380,160 or 6 stat. miles to an inch. By Frank Fletcher, F.L.S., Nelson B.C. *Presented by the Author.*

The present edition of this map has been corrected to 1897, and contains a large amount of information as to the location of minerals in the district. The blocks which have been surveyed by the author, and appeared on the earlier edition of this map for the first time, are also shown.

Patagonia. **Petermanns Geographische Mitteilungen.**

Karte der Chilenisch-Argentinischen Grenzregion im Feuerland. Nach den Aufnahmen der Subkommissionen 1894–1895. Scale 1 : 500,000 or 7·9 stat. miles to an inch. *Petermanns Geographische Mitteilungen*, Jahrgang 1897, Tafel 13. Gotha: Justus Perthes, 1897. *Presented by the Publisher.*

Peru. **Raimondi.**

Mapa del Peru. A. Raimondi. Scale 1 : 500,000 or 7·9 stat. miles to an inch. Engraved and printed by Erhard Bros., Paris. Sheets Nos. 26, 28, 30, 31, 32. *Presented by the Geographical Society of Lima.*

These five sheets include portions of Southern Peru, and appear to have been compiled from the most recent and reliable information. The hill-work is shaded in brown, and the rivers and lakes in blue, the combination being very effective. A full explanation of the symbols employed is given at the foot of each sheet.

Only five sheets now remain to complete this map, which is by far the best of this country which has ever been published.

AUSTRALASIA.

Tasmania. **Department of Lands and Surveys.**

Mineral and Land map of Tasmania. Scale 1 : 950,400 or 15 stat. miles to an inch. Department of Lands and Surveys. Hobart, 1897. *Presented by Land and Survey Office.*

Tasmania. **Department of Lands and Surveys.**

Map of Tasmania. Scale 1 : 506,800 or 8 stat. miles to an inch. Department of Lands and Surveys. Hobart, 1897. *Presented by Lands and Survey Office.*

GENERAL.

German Colonies. **Langhans.**

Deutscher Kolonial-Atlas, 30 Karten mit 300 Nebenkarten, entworfen, bearbeitet und herausgegeben von Paul Langhans. Erschient in 15 Lieferungen (jede mit 2 karten). Parts 13, 14, and 15. Gotha : Justus Perthes, 1897. *Price* 1 *mk.* 60 *pf. each part.*

Part xiii. contains No 7, showing German colonization in Eastern Europe; No. 19 is Sheet i. of a map of German East Africa. Part xiv. contains No. 8, map showing the distribution of Germans in North America; No. 22 is Sheet iv. of a map of German East Africa. Part xv. contains Nos. 20 and 21, Sheets ii. and iii. of a map of German East Africa, together with a table of contents of the atlas, and other explanatory matter.

With the issue of these parts this excellent atlas is now complete. The maps throughout have been compiled with the greatest care, they are beautifully drawn, are quite up to date of publication, and contain a vast amount of information with regard to the German colonies.

CHARTS.

Admiralty Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published at the Hydrographic Department, Admiralty, during July and August, 1897. *Presented by the Admiralty, through the Hydrographer.*

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2240	m = 1·2	Iceland, west coast :—Grundar and Kolgrafa fiords. 1*s.* 6*d.*
2692	m = 7·9	North America, east coast :—Louisburg harbour. 2*s.* 6*d.*
699	m = 7·0	Plans on the coast of Chile :—Esmeralda cove. 1*s.* 6*d.*
2889	m = 2·93	Plans on the coast of Peru :—Cerro Azul bay. 1*s.* 6*d.*
977	m = 3·0	Philippine islands :—Nin bay and Port Mandaon. 1*s.* 6*d.*
1926	m = 4·0	Formosa, west coast : —Anpei (Amping) anchorage. 1*s.* 6*d.*
2878	m = 5·8	Japan, Nipon, south coast :—Mera Koura. 1*s.* 6*d.*
2249	m = 5·4 m = 3·65	Ports on the east coast of Kiusiu :—Port Inokushi, Port Yonozu. 1*s.* 6*d.*
2985	m = 3·0	Japan :—Saiki bay. 1*s* 6*d.*
2277		White sea, Sheet ix. : – Plan added, Poria anchorage and approaches.
899		San Diego bay to Conception point, etc. :—Plan added, Santa Monica.
2797		Anchorages off the coast of California :—New Plans, Cuyler harbour, north-west harbour (San Clemente island), South-east harbour (San Clemente island).
1109		Harbours and anchorages in the Red Sea :—New plan, anchorage of Raweiya.
2388		Sea of Okhotsk :—Plan added, Ola anchorage.

(*J. D. Potter, agent.*)

Charts Cancelled.

No.		Cancelled by	No.
160	Civita Vecchia to Poli-castro.	New Chart.	
		Plans on the west coast of Italy . . .	160
2692	Louisburg harbour.	New Chart.	
		Louisburg harbour	2692
2530	Plan of Santa Monica on this sheet	New plan of Santa Monica on sheet . . .	899
962	Plan of bay of Nin and Port Mandaon on this sheet.	New Chart.	
700	Makambi river.	Nin bay and Port Mandaon , ...	977

Charts that have received Important Corrections.

No. 2175, England, south coast:—Poole harbour. 2800, Ireland, east coast:—Lough Carlingford. 2810, Ireland, east coast:—Lough Carlingford entrance. 125, Belgium:—Ostende roads. 300, Anchorages on the north and west coasts of Spitzbergen. 2842A, Baltic sea. 2289, Baltic sea:—The Skagerrak or Sleeve. 2297, Gulf of Bothnia:—Hango head to South Quarken. 2229, Denmark:—Entrance to Great and Little Belts. 2116, Baltic sea:—Great and Little belts. 438, France, north coast:—Cape d'Alprech to Ambleteuse. 86, Spain, west coast:—Cadiz harbour and approaches. 2157, Sardinia:—Maddalena and adjacent islands. 1189, Mediterranean:—Bonifacio strait. 867, Bermuda:—From the Narrows to Hamilton. 2740, Iceland and the Faeroe islands. 565, Iceland, western portion. 566, Iceland, eastern portion. 2733, Iceland:—Portland to Snefells Jökel. 1677, Newfoundland:—St. Margaret bay and Castors harbour. 797, River St. Lawrence:—Quebec to Kingston, etc. 1207, Central America:—River Dulce. 2344, Gulf of Mexico:—Mobile bay. 537, South America, north coast:—Ceara bay. 2530, United States, west coast:—San Diego bay to Cape Mendocino 570, British Columbia:—Quatsino sound. 592, British Columbia:—Barclay sound. 607, Africa, west coast:—Entrance to the Salum and Jumbas rivers. 1003, Africa, east coast:—River Pungue. 674, Africa, east coast:—Dar-es-Salaam harbour. 758, Madagascar:—Cape St. Andrew to Antongil bay. 378, Madagascar:—Maromanjo point to Makambytra bay. 823, Bay of Bengal:—Koronge island to White point. 833, Bay of Bengal:—Rangoon river and approaches. 825, Andaman islands. 941B, Eastern archipelago, western portion. 2636, Strait of Makassar, north part. 2637, Strait of Makassar, south part. 2577, Eastern archipelago:—Between St. Bernardino and Mindoro straits, with adjacent islands. 1260, China:—Chifu or Yen-tai harbour. 806, Japan:—Sendai bay to Miyako bay. 2759A, Australia, northern portion. 2650, Strait of Tartary and entrance of the Amur river. 1056, Australia, west coast:—Cape Cuvier to Champion bay. 1750, Australia, south coast:—Port Adelaide. 1018, Australia, east coast:—Montagu island to Beecroft head. 1460, Ports in Arafura sea. 1080, Tasmania:—Tamar river. 105, Tasmania:—Port Hobart. 2726, New Zealand:—Manukru harbour. 2685, New Zealand, south island:—Cook strait anchorages, Sheet 2. 2459, North-west Pacific ocean. 2658, Solomon islands:—Gavutu and Tulage harbours.
(*J. D. Potter, Agent.*)

United States Charts. **U.S. Hydrographic Office.**

Pilot Charts of the North Atlantic and North Pacific Oceans for September, 1897. Published at the Hydrographic Office, Washington, D.C. *Presented by the U.S. Hydrographic Office.*

PHOTOGRAPHS.

Jamaica. **Swinton.**

Ten Photographs of Jamaica, taken by Colonel A. Swinton, R.A., 1892. *Presented by Colonel A. Swinton, R.A.*

This is a series of enlargements, which are chiefly valuable as showing the tropical vegetation of the island of Jamaica. They are as follows: (1) Moneague; (2) Screw pine, Moneague; (3) Moneague; (4) Cotton tree, Moneague; (5) Cotton tree, Maudeville; (6) Cabbage palm, near Claremont; (7) Coco-nut palm, Moneague; (8) Royal palm, Spanish town; (9) Ocho Rios; (10) St. Anne's bay.

Mexico. **Stephenson.**

Fifty-four Photographs taken by J. Gurdon L. Stephenson, C.E., during the Mexican Western Railway Expedition, 1897. *Presented by J. Gurdon L. Stephenson, Esq.*

This series contains fifty-four photographs taken during the Mexican Western Railway Expedition, 1897. The greater number are photographs of the country through which the expedition passed. Among others, there are several illustrating the industries of the country, the natives and their dwellings, a Maya Indian war-dance, and ancient ruins. The following is a list of the subjects:—

(1) Fuerte river—Ford between Baca and Agua Caliente; (2) Hacienda, El Dorado, Agua Caliente; (3) Hacienda, El Dorado, Agua Caliente; (4) Hacienda, El Dorado, Agua Caliente; (5) Mr. J. Gurdon L. Stephenson, C.E., F.R.G.S., chief of the expedition—Mr. O. V. Lane, mining prospector; (6) Mr. A. Krauss, railway contractor, Bristol; (7) Mr. E. J. Moon, A.M. INST. C.E., chief engineer's assistant; (8) Don Francisco Lasselle, voluntary guide between Agua Caliente and Batopilus; (9) Doctoring a mule, Agua

Caliente; (10) Lanphar's distillery, Agua Caliente; (11) Carpenter's shop, Agua Caliente: (12, 13, 14) Maya Indian war-dance: (15, 16, 17) Dam and hot spring, Agua Caliente; (18) View of Agua Caliente; (19) House at Agua Caliente; (20) Lanpher's Tannery, Agua Caliente; (21, 22, 23, 24) Views of Agua Caliente; (25) Mount Rosario district; (26, 27, 28) Mount Rosario; (29) Chinipas valley, from La Guasa; (30) Septentrion valley, from La Guasa; (31, 32) Uvalama; (33) Ancient Spanish silver-mine workings at Septentrion, in the bottom of the cañon; (34) Ancient Aztec store prison at Septentrion; (35) Overlooking Septentrion; (36) Between Temoris and Behuina; (37, 38) Mamaripa cañon in the Sierra Madre; (39) Cuiteco; (40) Tannery, Cuiteco; (41) Church, Cuiteco; (42) Indian Mozo; (43) Indians at Cuiteco; (44) Between Cuiteco and Los Tascates; (45) Los Tascates, wooden plough; (46) Indian hut at Orichivo; (47) Barranca de Cobra; (48) Indian woman weaving at Barranca de Cobra; (49) Near Los Ajitos; (50) The judge's coach, Bocoyna; (51) The judge's house at Bocoyna; (52) Church at Bocoyna; (53) Indians, Bocoyna; (54) Indian children, Bocoyna.

Morocco. **Loch.**

Twenty-five Photographs of Morocco, taken by the Hon. E. D. Loch, during Sir Arthur Nicolson's Mission in 1896. *Presented by the Hon. E. D. Loch.*

This is a remarkably fine series of photographs, and the subjects are well chosen. It consists of the following:—

(1) Magador, taken from east; (2) Magador, taken from east; (3) Ain Rashá near Marakesh; (4) Glaiva pass taken from the Kasbah-el-Glaiva; (5) The Wad Nefis looking south, Atlas mountains in the distance; (6) Gateway leading towards Sultan's palace, Morocco city; (7) Two soldiers of the British Legation; (8) Gateway in Magador; (9) Gateway into the inner part of the Kasbah-el-Glaiva; (10) Sheik's house and Zarkteu at the northern entrance to Glaiva pass; (11) View looking north-west from top of Glaiva pass; (12) Avenue of orange and olive trees in the Mamonia palace, Morocco city, where the Embassy was quartered; (13) Kontabia mosque, Morocco city; (14) Kautara Wad-Tcusift, near Morocco city; (15) Group taken in the Kasbah-el Glaiva; (16) Government mosque, Morocco city; (17) No title; (18) No title; (19) Taken from the top of Glaiva pass looking south; (20) Kasbah-el-Glaiva (a large castle belonging to the Kaid of Glaiva, situated on the south side of the Atlas mountains); (21) Bridge over Wad Ghadat in Atlas mountains; (22) View of the Kasbah-el-Glaiva; (23) Jibel Ofrarz, taken from the north; (24) Jibel Glaiva, taken from a pass about 6000 feet above sea-level, and about 4000 feet above Zarkteu; (25) Haj Abslam Ould Haj Maati Meyanzi, Kaid of Shaonia.

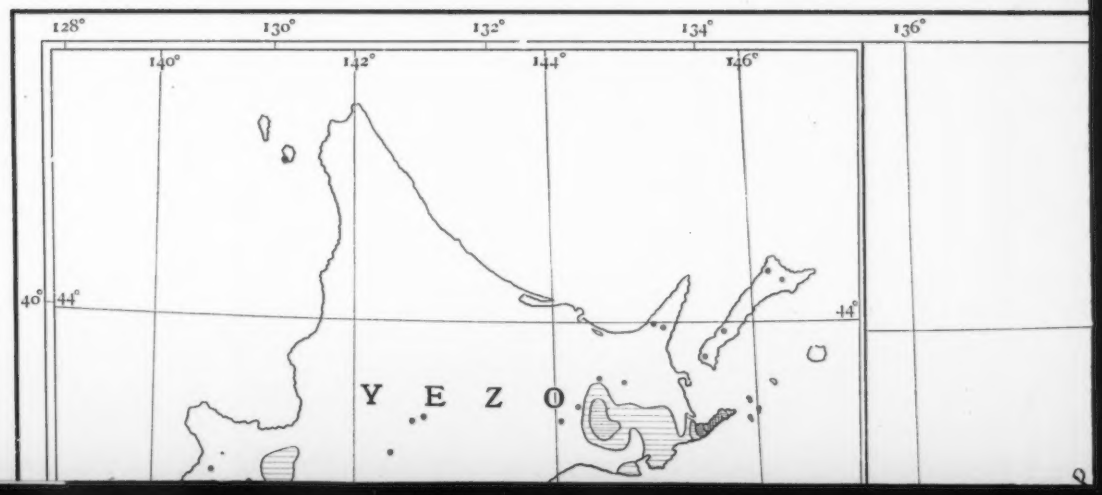
Persia. **Churchill.**

Sixteen Photographs taken in the neighbourhood of Resht, Persia, by H. L. Churchill, Esq. *Presented by H. L. Churchill, Esq.*

The following is a list of the subjects:—

(1) Peasant types of Resht; (2) Small waterfall in hills of Talish; (3) Persian tea picnic by river-side near Resht; (4) Type of Persian private tea-house, known by the name of Kolab Frangee, or "European hab," in large private garden at Resht; (5) Famous dervish at Resht; (6) Peasants returning to their villages after selling their wares at Resht; (7) Wayside shop hut at "Inek"—small lakes in shape of spectacles, showing humped bull in foreground; (8) Road being constructed by a Russian company between Resht and Kazneen; (9) Kilishter, Rahmelabad, near Menjil, between Resht and Kazneen; (10) View of Shah's Shanes ul Amaret, or "Palace of the Sun," Euzelli-Resht; (11) The Moonshee of the British Consulate, Resht; (12) Type of Persian dervish; (13) Clearing road, Resht to Peri Bazar; (14) Country house of Persian gentleman (this is the house where Sir M. Durand was entertained by the Persian Government on his first arrival in Persia in 1894); (15) View of Rahmetabad, showing construction of houses; (16) View of "Inek" Spectacles, Resht.

N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.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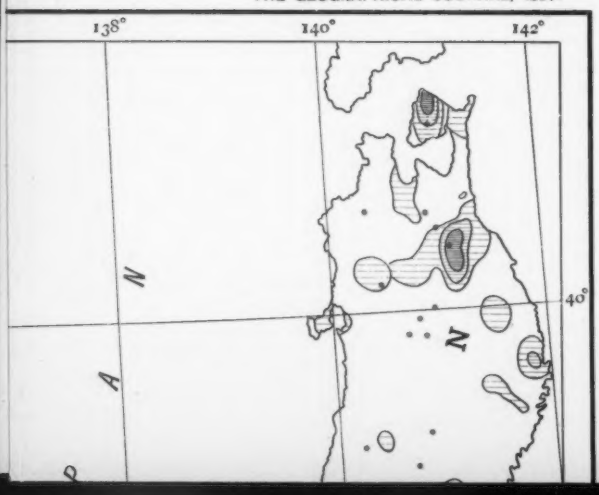
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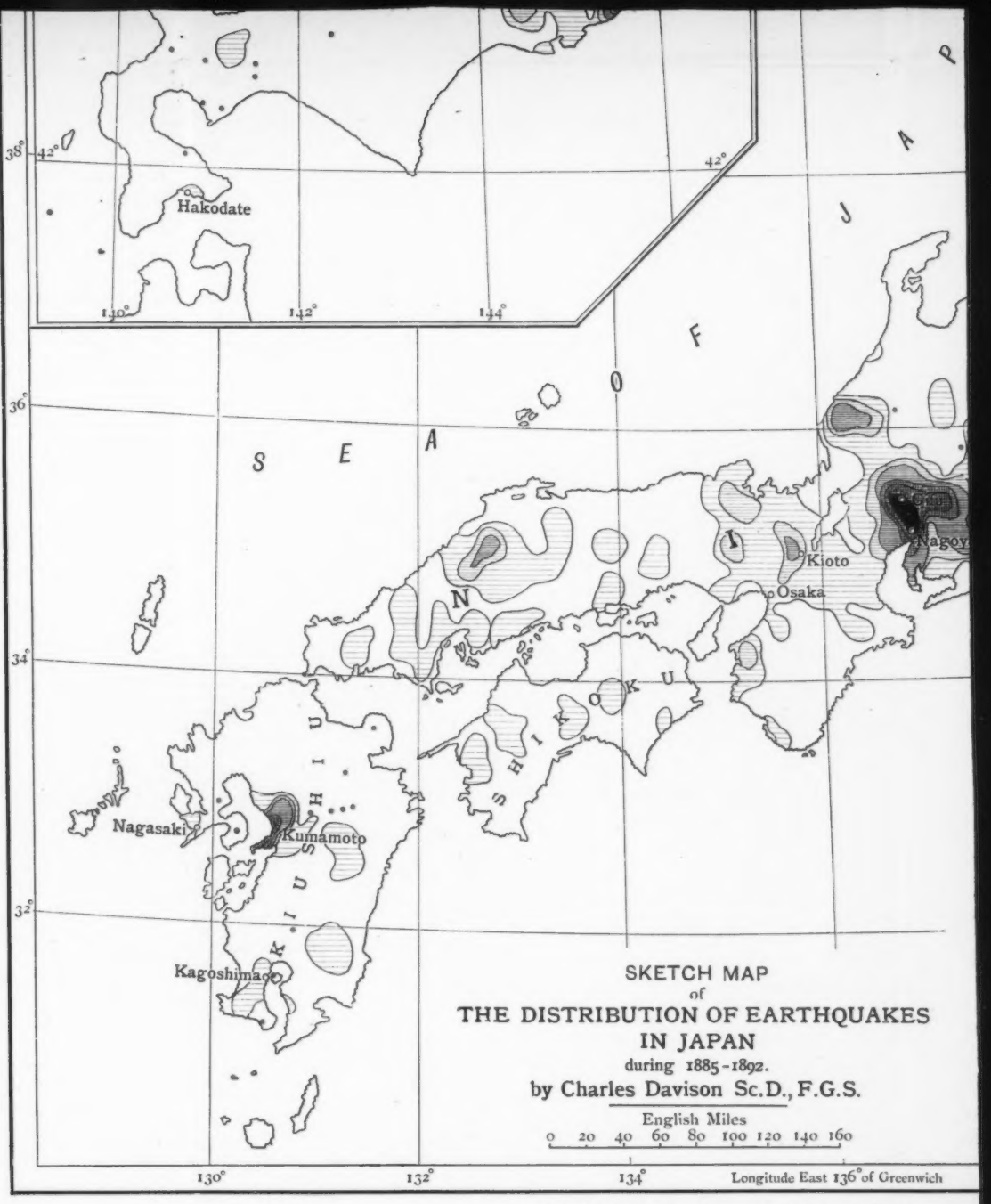
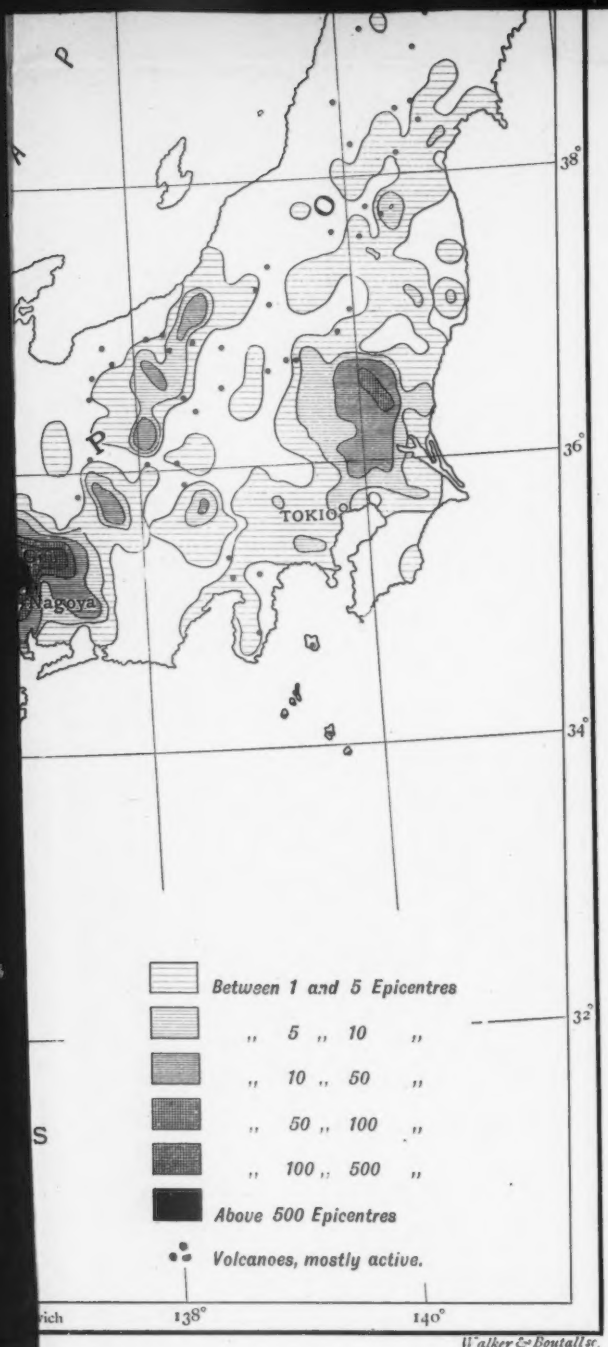


Published by the Royal Geographical Society, 1897.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